

B O A R D O F S T U D I E S
NEW SOUTH WALES

2012 HSC Chemistry **‘Sample Answers’**

When examination committees develop questions for the examination, they may write ‘sample answers’ or, in the case of some questions, ‘answers could include’. The committees do this to ensure that the questions will effectively assess students’ knowledge and skills.

This material is also provided to the Supervisor of Marking, to give some guidance about the nature and scope of the responses the committee expected students would produce. How sample answers are used at marking centres varies. Sample answers may be used extensively and even modified at the marking centre OR they may be considered only briefly at the beginning of marking. In a few cases, the sample answers may not be used at all at marking.

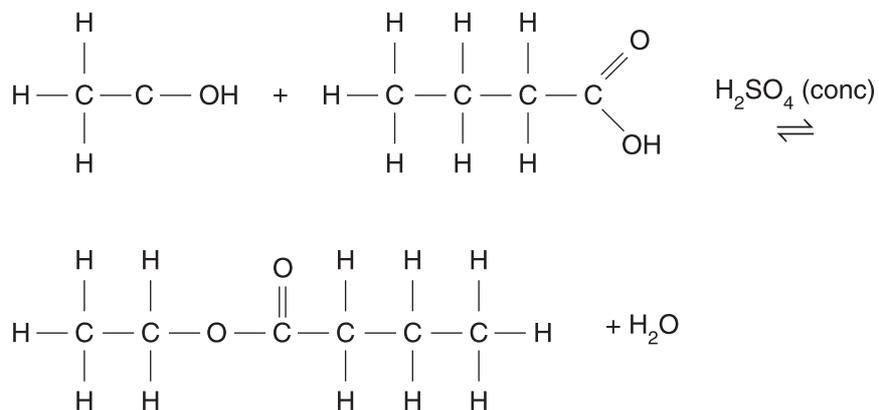
The Board publishes this information to assist in understanding how the marking guidelines were implemented.

The ‘sample answers’ or similar advice contained in this document are not intended to be exemplary or even complete answers or responses. As they are part of the examination committee’s ‘working document’, they may contain typographical errors, omissions, or only some of the possible correct answers.

Section I, Part B

Question 21 (a)

Sample answer:



Question 21 (b)

Sample answer:

A water bath is needed to heat the vessel as the reactants and products are volatile and are therefore a fire hazard if exposed to naked flames.

Question 22 (a)

Sample answer:

Polymerisation

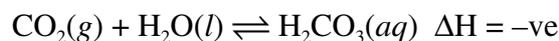
Question 22 (b)

Sample answer:

They are useful as they help visualise a process which cannot be seen. It shows the dynamic nature of the reaction allowing a deeper understanding of the reaction mechanisms. It allows you to appreciate the three-dimensional nature of the process.

Question 23***Sample answer:***

Carbon dioxide dissolves in water according to the following equilibrium:



An increase in pressure will result in more CO_2 dissolving and an increase in solubility. An increase in temperature will encourage the endothermic process to take place. In this case, the reverse reaction results in production of CO_2 and lower CO_2 solubility.

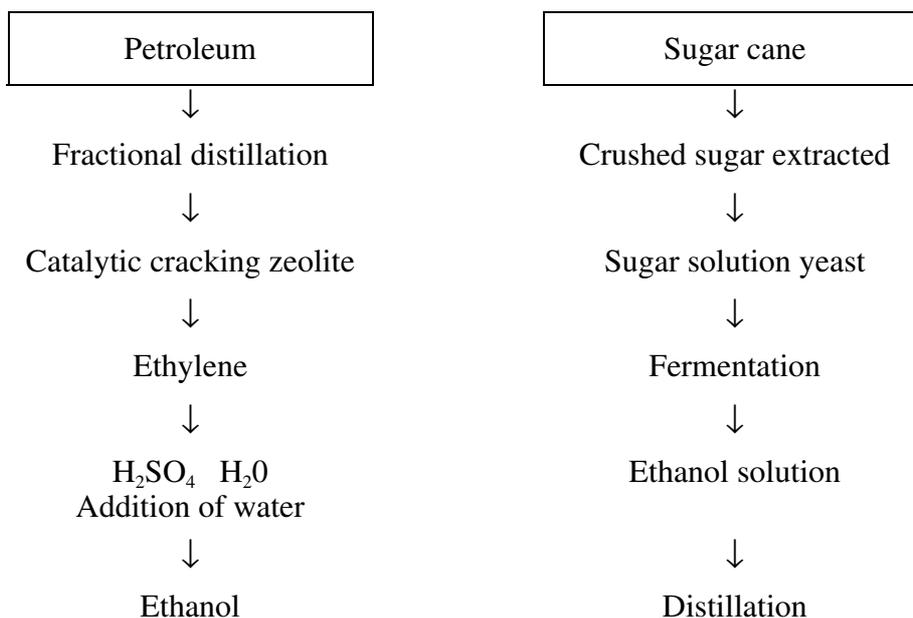
Question 24***Sample answer:***

Ammonia is important as it is used extensively in many industries. It is a raw material in agriculture for the making of fertilisers to increase crop production. It is used to produce explosives for wartime or construction and mining. Its importance can further be seen in its use in manufacturing synthetic fibres, cleaning products and pharmaceuticals.

Question 25***Sample answer:***

Eutrophication can be monitored by measuring the concentrations of nitrate and phosphate ions in samples of environmental water. When nitrate and phosphate levels increase (particularly phosphate) algal abundance increases dramatically, causing problems for the waterway.

These tests would need to be carried out regularly and at various locations to appropriately monitor nutrient levels, including nitrates, phosphates and oxygen, in order to monitor eutrophication and prevent the waterways becoming marsh-like or turning into swamps.

Question 26 (a)*Sample answer:***Question 26 (b)***Sample answer:*

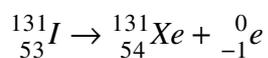
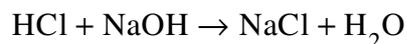
Petroleum is a finite resource and hence the production of ethanol from it is unsustainable in the long term, even if the use of ethanol as a petrol replacement reduces the demand for petrol as a fuel. It is unlikely that the conversion of petroleum to ethanol is 100% efficient in energy terms, so substituting ethanol fuel for petrol fuel will increase the rate of petroleum use. Production of ethanol from sugar cane, however, appears to be sustainable as sugar cane is a renewable resource and ultimately draws energy from the sun. There are costs associated with the process, such as the land area required to meet an increasing demand for ethanol. This raises questions regarding its long term environmental sustainability.

Answers could include:

Reference to fertiliser requirements.

Question 27 (a)**Sample answer:**

As β -particles do not travel far through tissue, they transfer their energy to cells near to the source of the radiation, killing nearby cells. This means that a β -emitter can be used for therapy, but as the radiation cannot be detected outside the body, it is of little use in determining where a radioisotope has been transported to. On the other hand, X-rays easily travel outside the body, so an γ -emitter can be used to determine where an isotope has been transported to, hence it is useful for diagnosis. Relatively little of the energy is transformed to nearby tissue, so an internal γ -emitter is not appropriate for killing targeted cells.

Question 27 (b)**Sample answer:****Question 28****Sample answer:**

$$\begin{aligned}\text{mol H}_3\text{O}^+ &= c \times v \\ &= 0.120 \times 0.07500 \\ &= 0.00900 \text{ moles}\end{aligned}$$

$$\begin{aligned}\text{mol OH} &= 0.02500 \times 0.200 \\ &= 0.00500 \text{ moles}\end{aligned}$$

$$\begin{aligned}\text{mol H}_3\text{O}^+ \text{ excess} &= 9 \times 10^{-3} - 5 \times 10^{-3} \\ &= 4.00 \times 10^{-3}\end{aligned}$$

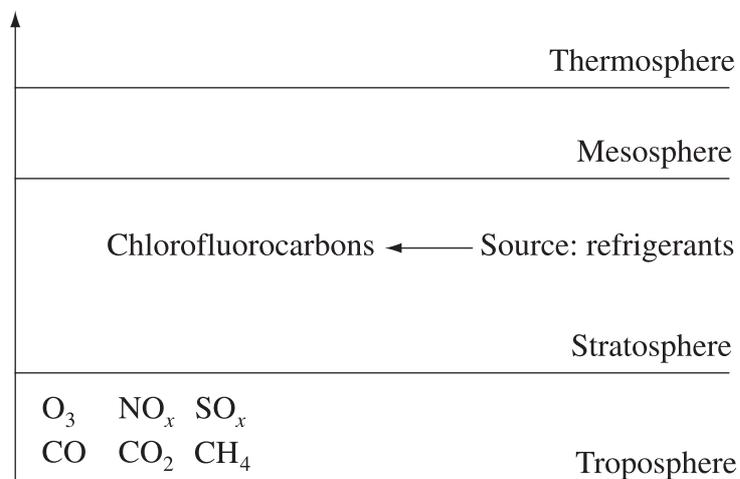
$$\begin{aligned}[\text{H}_3\text{O}^+] &= 4 \times 10^{-3} \div 0.100 \\ &= 4.00 \times 10^{-2}\end{aligned}$$

$$\begin{aligned}\text{pH} &= -\log_{10}[\text{H}_3\text{O}^+] \\ &= 1.40\end{aligned}$$

OR 1.4

Question 29

Sample answer:



Sources

O₃ – photo-oxidation or industrial production of O· → O₃

CO – incomplete combustion, motor vehicles, other combustion

NO_x – internal combustion engine

SO_x – fossil fuels combustion

CO₂ – fossil fuels

CH₄ – agriculture, anaerobic processes

Question 30 (a)

Sample answer:

$$\text{mol HCl} = c \times v$$

$$= 0.1034 \times 0.02500$$

$$= 2.585 \times 10^{-3}$$

$$= \text{mol OH}^-$$

$$[\text{OH}^-] = \frac{\text{mol OH}^-}{v}$$

$$= \frac{2.585 \times 10^{-3}}{0.02575}$$

$$= 0.1004 \text{ mol L}^{-1}$$

Question 30 (b) (i)**Sample answer:**

$$\text{mol HCl} = c \times v$$

$$= 0.1004 \times 0.01655$$

$$= 1.661 \times 10^{-3} \text{ moles}$$

$$= \text{mol aspirin}$$

$$\text{MM C}_9\text{H}_8\text{O}_4 = 180.154 \text{ (} 9 \times 12.01 + 8 \times 1.008 + 4 \times 16.00 \text{)}$$

$$\text{Mass MM C}_9\text{H}_8\text{O}_4 = n \times \text{MM}$$

$$= 1.661 \times 10^{-3}$$

$$= 0.2993 \text{ g}$$

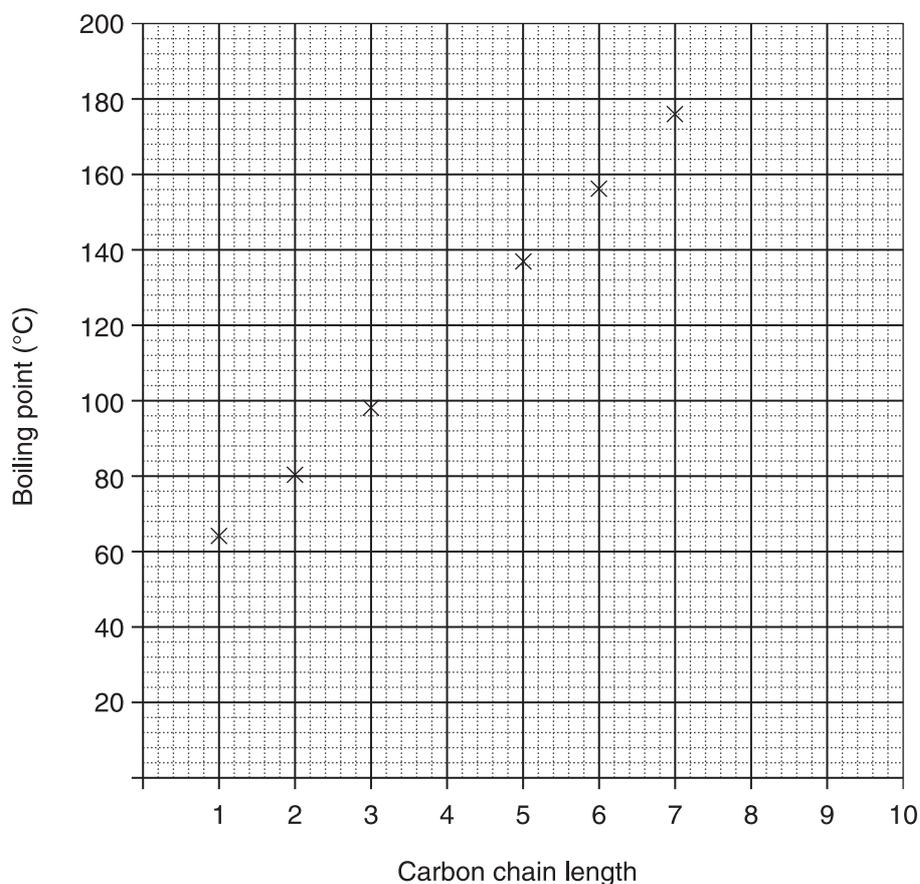
$$= 299.3 \text{ mg}$$

Answers could include:*Do not penalise for a carry-through error from 30 (a)***Question 30 (b) (ii)****Sample answer:**

Ethanol is required to improve the solubility of the aspirin.

Question 31 (a)

Sample answer:


Question 31 (b)

Sample answer:

120°C (range 118–122°C)

Question 31 (c)

Sample answer:

As carbon number increases, dispersion forces increase and therefore boiling point increases.

Answers should NOT include:

Hydrogen bonding or dipole/dipole interactions

Question 32***Sample answer:***

[Marks graph to show concentration derived]

Hg concentration in sample solution from calibration curve = 0.17 mg L^{-1}

mg Hg in sample solution = $0.17 \text{ mg L}^{-1} \times 0.0250 \text{ L}$

$$= 0.00425 \text{ mg}$$

mg Hg/kg fish = $0.00425 \text{ mg} / 0.0186 \text{ kg}$

$$= 0.23 \text{ mg / kg}$$

The consumer can eat this fish species because the mean concentration from analysis of 0.23 mg/kg is less than the maximum permitted 0.5 mg/kg.

Question 33

Sample answer:

Chemists need to collaborate when monitoring the impact of materials so that our demand for products and services does not adversely affect the environment.

Take, for example, our demand for technology and therefore for electricity. Lead-acid batteries provide high currents and are therefore used as car batteries, and are also useful storage batteries for remote locations. They are rechargeable and therefore may be seen in some ways as environmentally friendly, yet the materials contained within the battery may create significant problems.

In minimising these risks, it is essential that chemists of different specialities work together. An environmental chemist will be able to determine the natural background levels of lead in the environment and provide information relevant to the setting of industry standards and environmental regulations relating to lead concentrations in effluent or atmospheric emissions.

Analytical chemists are essential to the process of monitoring the environmental impact by accurately detecting and measuring the amount of lead present at times during the manufacturing and recycling process. Techniques such as AAS would need to be used to ensure that even the smallest amounts of lead could be monitored, as trace amounts of lead have the potential to cause environmental problems.

While the damage may not be able to be reversed once the lead has escaped into the environment, industrial chemists and materials chemists can contribute to minimising environmental problems by devising alternative production methods and alternative products. In this case the development of lithium batteries and other types of cells can assist in ensuring little environmental damage results from our love of technology and demand for products.

Without working together, the danger exists that each chemist will become too focused on their own area of speciality and immediate context and miss opportunities to ensure the quality of our environment is maintained or even improved.

Answers could include:

- The role of an analytical chemist in devising and performing analytical techniques
- The role of mineral chemists/industrial chemists from mining industries in identifying environmental concerns in the extraction of materials, melting of metals and in the solving or minimising of these risks
- The health risks associated with accumulation of heavy metals
- The dry-cell could be used as an alternative example where the extraction of limited resources and the disposal of used cells pose environmental concerns and the acidic nature of the components could be discussed
- The benefits of collaboration in terms of broadened experience, refinement of ideas through discussion and/or benefits of teamwork generally

Section II

Question 34 (a)

Sample answer:

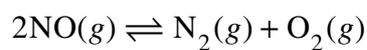
Electrolysis

Electrode P – $\text{Cl}_2(g)$ or $\text{O}_2(g)$

Electrode Q – $\text{H}_2(g)$

Question 34 (b) (i)

Sample answer:



Question 34 (b) (ii)

Sample answer:

	Initial	Change	Equilibrium
NO	0.400	0.396	0.004
N_2	0	0.198	0.198
O_2	0	0.198	0.198

$$K = \frac{0.198 \times 0.198}{0.004^2} \\ = 2450$$

As $K > 10^3$, therefore the equilibrium lies to the RHS/products.

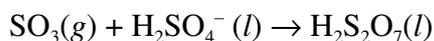
Question 34 (b) (iii)

Sample answer:

Temperature

Question 34 (c) (i)**Sample answer:**

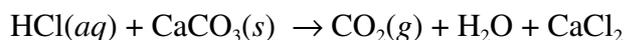
$\text{SO}_3(\text{g})$ is combined with a mist of concentrated sulfuric acid producing liquid oleum ($\text{H}_2\text{S}_2\text{O}_7$) according to the equation below



Water is added to this substance to produce two molecules of sulfuric acid without excess water.

**Question 34 (c) (ii)****Sample answer:**

$\text{SO}_3(\text{g})$ is converted into oleum before $\text{H}_2\text{SO}_4(\text{l})$ is formed because the direct reaction of $\text{SO}_3(\text{g})$ with $\text{H}_2\text{O}(\text{l})$ is highly exothermic and forms an H_2SO_4 mist which is difficult to turn back into H_2SO_4 liquid.

Question 34 (d) (i)**Sample answer:**

↓

Bubbled through ammoniacal
brine in ice bath

↓

Solid NaHCO_3 produced

Answers could include:

Thermal decomposition of solid NaHCO_3

Reaction of CaO (with H_2O) $\rightarrow \text{Ca}(\text{OH})_2$

Recovery of NH_3 by reacting $\text{NH}_4\text{Cl}(\text{aq})$ with aqueous $\text{Ca}(\text{OH})_2$

Question 34 (d) (ii)**Answers could include:**

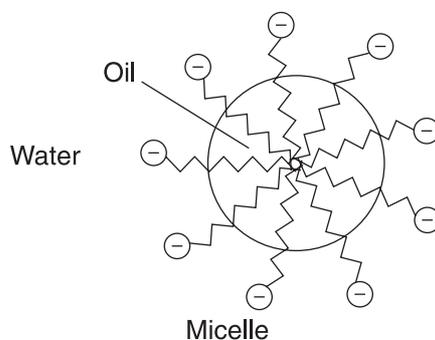
- The use of concentrated HCl can lead to acid burns if not handled correctly
- Industrially CO_2 is produced by the thermal decomposition of CaCO_3 rather than its reaction with acid. This presents challenges with the use of a furnace and collection of the gas produced.
- Relevant risk factors and difficulties corresponding to the manner in which a step is modelled

Question 34 (e)
Sample answer:

Soaps have historically been used as cleaning agents. They are derived from the base hydrolysis of fats and oils, which are triesters of glycerol with fatty acids. The soaps formed are the sodium salts (generally) of fatty acids and as such have an ionic polar end and a non-ionic non-polar end (tail).



This polar hydrophilic end is able to interact with water and the hydrophobic non-polar end interacts with fats/oils and dirt in mixtures with water forming structures called micelles that allow contaminant materials to be removed.



This cleaning function is disrupted in hard water as the Mg and Ca salts of fatty acids are insoluble.

Industrial surfactants (detergents) do not precipitate in hard water and therefore retain their cleaning action. This is an improvement over soap and, in addition to this, these materials can be derived from the petrochemical industry which, while finite, has greater availability than the natural fat and oil supplies.

The early industrial detergents persisted in the environment as they were not biodegradable, and had harmful impacts on the environment.

The nature of industrial surfactants means that the polar end can be due to a benzene sulfonyl group producing a detergent with an anionic end suitable for general cleaning.



The polar end can also be due to a tertiary ammonium ion bonded to alkyl groups, making this detergent useful for uses such as conditioner, disinfectant and antiseptics.



While anionic surfactants have a polar end due to oxygen atoms in the chain and a terminal alkanol group, these surfactants are useful for low-sudsing applications such as dishwashers, paints, pesticides and cosmetics.



More recently produced detergents are biodegradable and have a reduced impact on the environment as well as having a lower phosphate content with subsequent reduced episodes of eutrophication.

The main pressures driving these changes are the limited supply of the materials used to produce soaps, the increasing range of applications for detergents, ability to function in hard water conditions and environmental considerations such as biodegradability and the use of phosphate as a builder in detergents.

Question 35 (a)

Sample answer:

Breaking the sealed container allows the seawater to escape, which will lead to the artefact drying out. This would concern the maritime archaeologists as the evaporation of a saturated solution (like seawater) will form salt crystals that can destroy the cellular structure of wood or could cause cracks in other materials due to the increase in size.

Answers could include:

Flaking of material as salt crystals form

Question 35 (b) (i)

Sample answer:

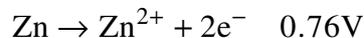
This method works by having an impressed current travelling through the pipe to ensure the steel pipe does not corrode. The wet terrestrial environment would allow for a galvanic reaction in which the iron is oxidised. Ensuring the pipe is made the cathode when connecting the power source provides electrons and prevents the iron from being oxidised. The graphite anodes assist in also ensuring no other reactions occur and, along with the damp conditions underground, complete the required circuit.

Answers could include:

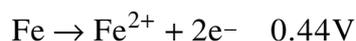
Half equation for iron (but not necessary)

Question 35 (b) (ii)**Sample answer:**

The pipe could also be protected by adding a sacrificial anode in contact with the steel. For example pieces of zinc would be preferentially oxidised according to the equation:



which has a greater potential than that of iron



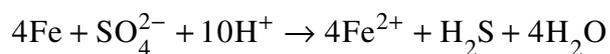
Therefore, in contact with each other, the iron will be reduced, protecting the steel pipe.

Answers could include:

- Any suitable choice of metal more active than iron
- Could include physical protections if chemical equations for rusting are given with appropriate explanation

Question 35 (c) (i)**Answers could include:**

- Process occurs at depths in the ocean
- Anaerobic bacteria must be present
- SO_4^{2-} ions must also be present

Question 35 (c) (ii)**Sample answer:**

$$0.76\text{g H}_2\text{S} = \frac{0.76}{34.086} = 2.23 \times 10^{-2} \text{ moles}$$

$$\therefore \text{ moles Fe reacted} = 2.23 \times 10^{-2} \times 4 = 8.92 \times 10^{-2} \text{ moles}$$

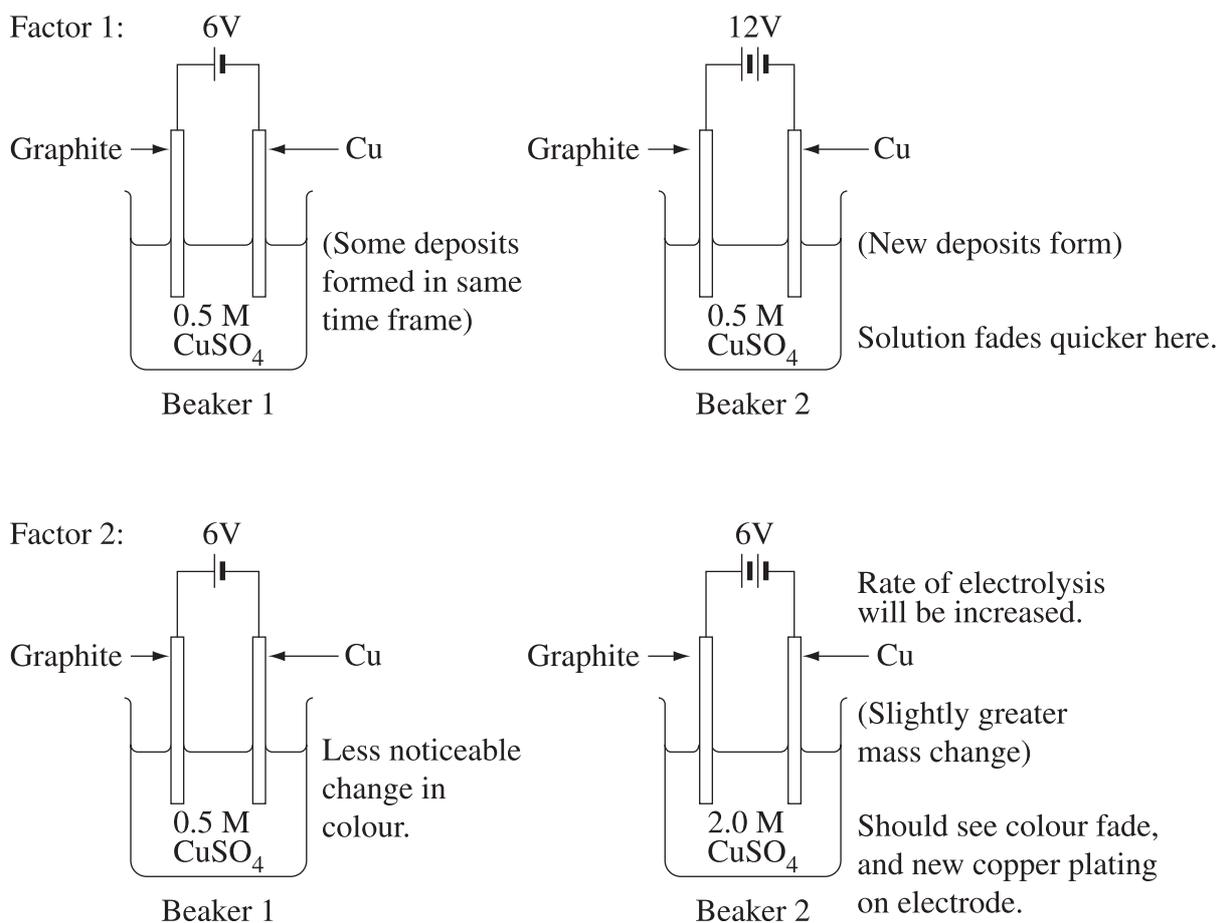
$$\begin{aligned} \therefore \text{ moles Fe lost} &= 8.92 \times 10^{-2} \text{ mol} \times 55.85 \text{ g mol}^{-1} \\ &= 4.98 \text{ g} \end{aligned}$$

Question 35 (d) (i)
Sample answer:

A valid investigation would test one variable at a time. In the beakers shown there is variation in electrode size, electrolyte concentration and the voltage applied. Hence the investigation is not valid.

Answers could include:

- A difference will be seen in the two beakers, yet the factors affecting electrolysis cannot be determined due to the combination of variables changed
- The lack of labelling of the second electrode means the nature of the two electrodes could also vary in the investigation

Question 35 (d) (ii)
Sample answer:


Question 35 (e)***Sample answer:***

Steel is used in ship building due to its strength, the capability to build larger vessels and its relatively low cost. Yet it corrodes quickly in marine environments due to the rusting of iron and needs to be protected.

Historically ships have been built of wood, or using copper and copper alloys. Wooden vessels were subject to decay from marine organisms, such as shipworm, which would limit the vessel's lifetime. Barnacles and other encrustations attaching to the hull also slowed the progress of the ships through the water. Inclusion of metal sheaths and metal fastenings, increased the size of vessels able to be built and copper inhibited the number of barnacles on the hull, providing longer-lasting and faster ships.

The advent of steel during the industrial revolution allowed for even larger vessels and for ships to become powered by petroleum fuels rather than wind. These advantages made steel the material of choice, although initial iron hulls had to be dry-docked and repaired regularly due to problems with rust.

Steels containing passivating metals provide a possible solution to the problem of corrosion, as a passivating layer is formed. However these can be expensive. For example, the high percentage of chromium in stainless steel protects the iron by creating an impervious layer. Steels containing nickel are a viable alternative, also having high corrosion resistance but lower cost.

Cheaper methods of protecting steel include creating physical barriers and using cathodic methods. The use of paints, lacquers and polymer-based coatings prevent the steel from coming into contact with seawater and hence prevent corrosion, allowing steel ships to make longer voyages and increasing their service time between dry-docking.

Galvanised coatings perform relatively well in seawater and are used in fixtures and fittings during shipbuilding. This provides a cost-efficient way of protecting the steel as combinations of materials are used throughout the ship.

In addition, an impressed current may be used to ensure the steel does not become part of a spontaneous galvanic cell. An applied voltage may be attached to the hull, drive shaft and/or bearings, making them the cathode and thus preventing the oxidation of the iron in the steel.

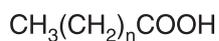
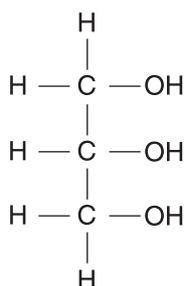
Steel, when properly protected, provides a durable and economic material for the building of ships and, despite the development of other materials, remains in use today.

Question 36 (a)***Sample answer:***

Protein X = actin

Protein Y = myosin

Metal ion Z = Ca^{2+} = calcium ions

Question 36 (b) (i)*Sample answer:***Question 36 (b) (ii)***Sample answer:***Question 36 (b) (iii)***Sample answer:*

Glycerol is a 3-carbon alcohol with 3-OH groups making it extremely polar and very soluble in water.

Fatty acids have a group ($-\text{COOH}$) which is polar but negated by the non-polar hydrocarbon chain. This means fatty acids become less soluble with increasing chain length.

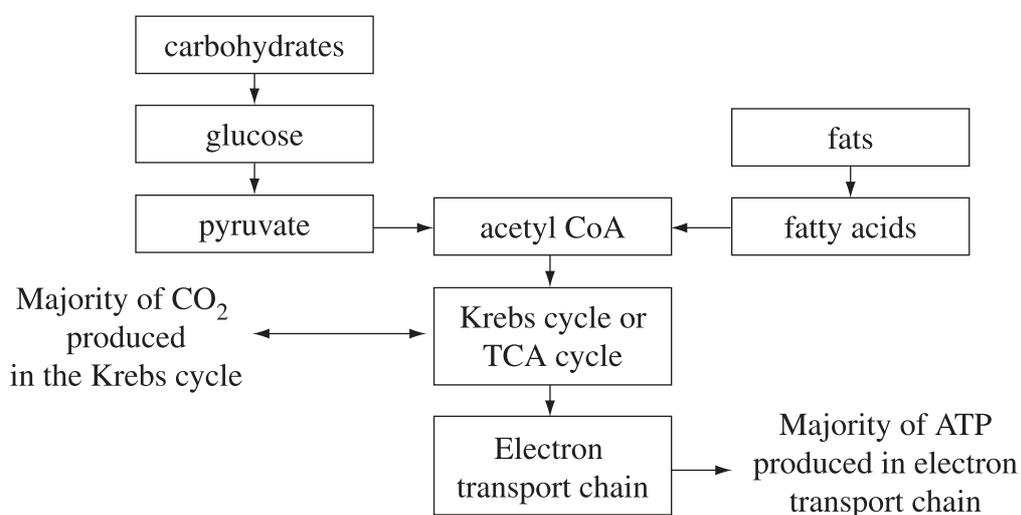
Triacylglycerols are triple esters of glycerol. This means that there are no $-\text{OH}$ groups and therefore these molecules are insoluble in water.

Question 36 (c) (i)
Sample answer:

Energy arises from oxidation. Carbohydrates can be considered as partially oxidised already relative to fats, thus it has less energy than fats.

Answers could include:

Fats have more C–H, C–C bonds to be oxidised.

Question 36 (c) (ii)
Sample answer:

Answers could include:

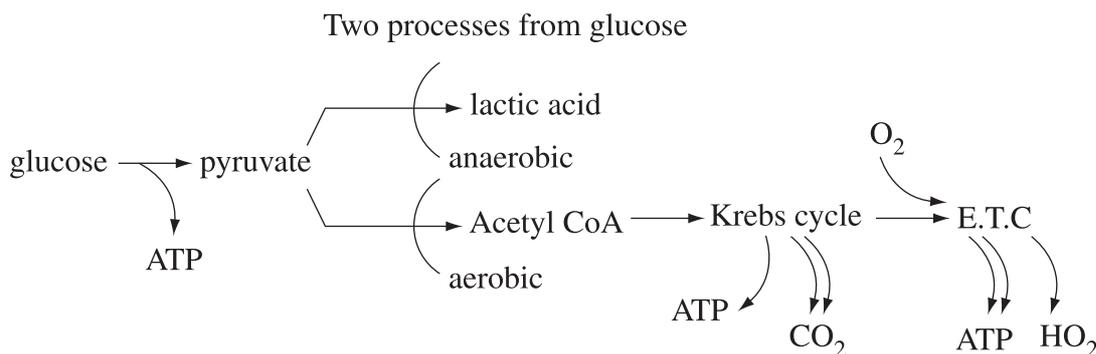
- TCA (tricarboxylic acid) cycle
 - Electron transport chain called oxidative phosphorylation
- Fatty acids → Acetyl CoA as 2 carbons step or β oxidation of fatty acid

Question 36 (d) (i)
Sample answer:

The primary structure of a protein is the sequence of amino acids joined by peptide bonds. The secondary structure depends on H-bonds between -OH and NH_2 groups. Bonding that determines the tertiary structure is a combination of electrostatic forces, H-bonding, hydrophobic forces and disulfide bonds.

Question 36 (d) (ii)
Sample answer:

The secondary structure will be denatured by a change in pH due to an increase/decrease of H^+ by disruption of H-bonds.

Question 36 (e)
Sample answer:


Intensity and duration of exercise determine whether muscle cells use anaerobic or aerobic metabolism. Muscles store very little ATP, so it is quickly exhausted and requires replenishing. The anaerobic system has faster response and does not depend on oxygen delivery. However, its by-product, lactic acid, causes muscle fatigue, so it is suitable only for intense short duration activity. The aerobic path has slower response and is dependent on oxygen delivery. However, compared to the anaerobic system it is unlimited in energy production, so is used for endurance exercise as no lactic acid build up occurs.

An important comparison between the two paths is in the energy production. The lactic acid production is fast but delivers only a small portion of the total energy available in glucose. All this energy is captured via the aerobic metabolism. The extra energy not used by an aerobic metabolism is not lost, as lactic acid is later resynthesised to pyruvic acid.

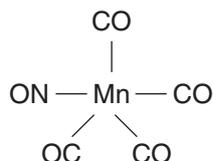
Question 37 (a) (i)

Sample answer:

Oxidation state is 3⁺

Question 37 (a) (ii)

Sample answer:



Ligands are Lewis bases. An initially unshared electron or electron pair from the ligand (CO and NO in this case) forms a coordinate covalent bond to the central metal atom or ion (Mn in this case). In this case, all ligands are monodentate.

Question 37 (b) (i)

Sample answer:

A reason is that the compound is water-soluble and would not be stable under humid conditions. The pigment would dissolve and run, smearing into adjacent areas of the artwork or being lost entirely.

Answers could include:

A reason is that under dry conditions the waters of hydration may be lost, resulting in a loss of the blue colour. The compound would go white and 'chalky'.

Question 37 (b) (ii)

Sample answer:

Tempera: Pigment is mixed with a water-soluble binder, such as egg yolk or other 'size' (gelatin, honey, plant gum) and painted onto the surface and the mixture allowed to dry. The result is a bond between the pigment and the 'size', and the 'size' and the surface, holding the pigment in place.

Answers could include:

Gilding is a named process. A surface is prepared by coating it with base material to seal and smooth it. Typically an egg white/iron(III) oxide clay mix was used. The iron(III) oxide is used to add a lustre to the overlaying foil. The surface is coated with an adhesive, typically egg white. Metal foil (typically gold foil) is pressed against the wet adhesive and 'burnished' to lustre.

Question 37 (c)**Sample answer:**

Ionisation energy is the energy required to completely separate an electron from a gaseous atom or ion. As electrons are successively removed, the remaining electrons are more energetically stable because there is less electron-electron repulsion occurring, hence each successive electron is more difficult to remove. A large jump occurs between the 5th and 6th step because the 6th electron is the first of the inner shell (3p) electrons, which are significantly more stable than the 5 valence shell electrons (3d³ 4s²).

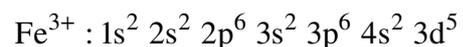
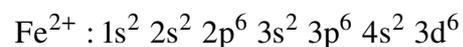
Question 37 (d) (i)**Sample answer:**

The FeCl₂(s) is dissolved in distilled water, making the solution sufficiently concentrated for the colour to be easily seen. A platinum loop is heated to red-hot in a blue bunsen flame to remove any contaminants, allowed to cool and used to place some of the solution into the flame. The flame colour is noted.

The solution is then oxidised by an oxidising agent that does not contribute its own colour, either to the solution or the flame test, and the flame test is repeated. The colour of the flame is used to represent the colour of the iron ion.

Answers could include:

- Use of spectrometer or spectroscope
- Discussion of colour of oxidising agent, eg KMnO₄, and use of stoichiometric amounts to give colourless, reduced oxidising agent

Question 37 (d) (ii)**Sample answer:****Answers could include:**

Question 37 (e)***Sample answer:***

The Bohr model of the atom was developed to use the quantisation of energy to explain the emission and absorption spectrum of hydrogen. It proposed that the single electron of the atom was confined to defined orbits around the nucleus, somewhat analogous to a planet's orbit around its star. For the electron to change to a different orbit, energy had to be absorbed (to go to a higher energy orbit) or emitted (to go to a lower energy orbit).

The energy absorbed or emitted is well-defined, giving rise to sharp absorption or emission lines. No other changes in energy are allowed. The model was an important step towards understanding and accepting the quantum view of the atom and introduced the idea of energy levels (shells) to describe the electronic configuration of atoms.

The Bohr model could not be applied to atoms other than hydrogen and did not provide any explanation for the quantisation. These restrictions and limitations of the model were recognised by Bohr and the model was not meant to be used beyond the hydrogen atom, but the attractiveness of the simplicity of the model has ensured continued use and propagates the incorrect concept of electrons as particles orbiting a nucleus.

Question 38 (a)***Sample answer:***

Soils are often specific to particular regions (The shapes of the particles may also vary depending on the method of erosion or weathering. By analysing the pH, mineral content, different micro fossils, particle size and colour of the soil forensic chemists can often match soil samples to specific sites to trace their origins, eg large quantity of quartz found in Eastern Australian soils) as they may contain minerals from the surrounding rocks.)

Question 38 (b) (i)***Sample answer:***

In order for forensic evidence to be valid, legally acceptable or well founded, there can be no chance that tampering or contamination has occurred. Any experimental results must also be accurately performed. To ensure that no contamination occurs the samples are put in sterilised containers, sealed and stored in conditions that will not allow degradation of the sample. To ensure accuracy, certified analytical chemists test the samples in accredited laboratories. Where and what happens to samples is carefully documented, seals signed and samples properly labelled following strict procedures to ensure that there has been no chance of tampering. Using bottles that are sealed and break on opening ensures the samples cannot be switched. This allows a proper chain of custody to be established. Using two samples and qualified chemists ensures reliability of the tests for athletes.

Question 38 (b) (ii)***Sample answer:***

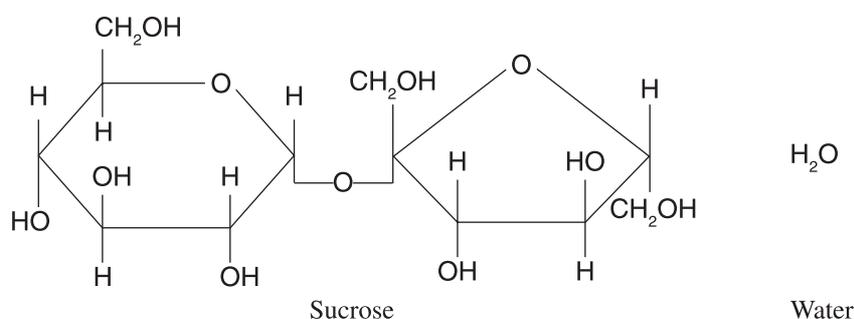
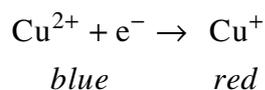
In the Christine Jessop murder case her neighbour Guy Morin was charged with her murder. When he was originally convicted the prosecution relied on hair and fibre findings as evidence. At the time of the trial DNA fingerprinting had not been perfected. In 1995 the genetic tests showed that Guy Morin was not the killer. This advance in technology changed the verdict.

Question 38 (c) (i)***Sample answer:***

The mixture is separated as the solvent rises by capillary action up through the paper. Each component of the pigment mixture will adhere to the paper and be carried up in the liquid to a differing degree depending on the polarity of the component. You can tell carotene is the least polar as it will be dissolved most in the hexane and adhere least to the polar paper. It will be carried up the paper more quickly and be found at the top of the paper, while the slightly more polar components will adhere to the paper more and be slowed down, appearing further down the paper.

Question 38 (c) (ii)
Sample answer:

The separation depends on the differences in the component's solubility in the chosen solvent and its adherence to the paper. To achieve a good separation the differences between these combined characteristics need to be great enough to slow the chemicals at different rates to ensure distinct lines are formed. If the solvent is changed the differences could change as the solubility will change and hence more, less or even no separation could occur. The order in which the components run up the paper could also change if, for example a fairly polar solvent is used instead of a fairly non-polar solvent. In the first case the more polar component would be at the top as like dissolves like and the non-polar would be at the bottom.

Question 38 (d) (i)
Sample answer:

Question 38 (d) (ii)
Sample answer:


Benedict's solution is a suitable reagent to identify a reducing sugar. Place 4 ml Benedict's solution (which contains Cu²⁺) in a test tube with 4 ml of the dissolved sugar to be tested. Gently heat the solution in a water bath. The reducing sugars (fructose and glucose) will change the solution from blue to brick red. Non-reducing sugars will not react and the solution will remain blue.

Question 38 (e)***Sample answer:***

The DNA molecule is a polymer which consists of a double helix. Each strand or section of strand of the double helix is complementary to the other due to the strict pairing of A with T and G with C. This allows the DNA to be replicated exactly, as when the strands unwind, each strand or fragment will act as a template for the new complementary strand, making it perfect for replication.

PCR is used to replicate 100s of billions of copies of a specific sequence of DNA. The DNA must first be heated to separate the strands of the molecule. Due to the fact that the strands are connected together via hydrogen bonds the molecule can be denatured or split into its strands with heat. The strand will duplicate or attach primers when the temperature is lowered. It also allows for primers to attach to specific areas. Primers help produce fragments of DNA to be reproduced in quantities which can be analysed. Two primers (usually tagged) are designed to match to the segment of DNA you want to copy.

Through complementary base pairing, one primer attaches to the top strand at one end of your segment of interest. The other primer attaches to the bottom strand at the other end of the section you wish to replicate. The segments of interest are the short tandem repeats which are sections on the introns (non coding DNA which is unique to individuals except twins). The various short tandem repeat sections in the molecule will vary in length from person to person (distinct patterns of ACGT may be repeated 4 times for one person and 8 times for another person). This means that the fragments are of varying lengths for each individual. A number of different STR's are targeted as this will improve the certainty of obtaining a unique profile. The next process is the separation of the fragments. As the DNA fragments are negatively charged, due to the phosphate groups that make up the backbone of DNA, molecules have a negative charge and will vary in length. The fragments can then be separated out by gel electrophoresis. Electrophoresis uses a gel matrix to slow down particles according to length and the voltage applied will make the DNA fragments migrate towards the positive terminal. The resulting fragment pattern or profile is found in the gel as shorter lengths travel further. The fragments can be viewed if radioactive or fluorescent tags are developed. The profile can be analysed and is unique to each individual. DNA profiles can therefore be matched to individuals.