

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

2010 HSC Chemistry Sample Answers

This document contains 'sample answers', or, in the case of some questions, 'answers could include'. These are developed by the examination committee for two purposes. The committee does this:

- (a) as part of the development of the examination paper to ensure the questions will effectively assess students' knowledge and skills, and
- (b) in order to provide some advice to the Supervisor of Marking about the nature and scope of the responses expected of students.

The 'sample answers' or similar advice 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

Sample answer:

Hydrochloric acid is a strong acid and therefore fully ionises in aqueous solution.

Ethanoic acid is a weak acid and does not fully ionise in aqueous solution.

The total concentration of ethanoic acid must be higher than that of HCl, due to incomplete ionisation of CH_3COOH , to give an equivalent $[\text{H}^+]$ and therefore pH, as pH is equal to $-\log_{10} [\text{H}^+]$.

Question 22 (a)

Answers could include:

Esters can be used for perfumes, flavouring and medicinal uses.

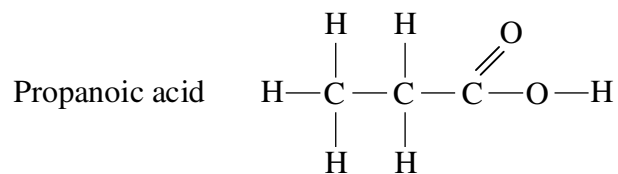
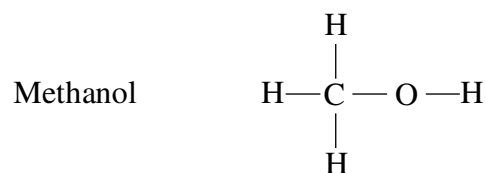
Question 22 (b)

Sample answer:

Too slow at room temperature. Reaction needs to be heated in an open container and as reactants are volatile, refluxing prevents loss of material. Reaction occurs in gas phase and therefore increases rate of reaction.

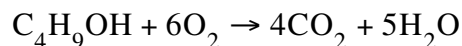
Question 22 (c)

Sample answer:



Question 23 (a)

Sample answer:

**Question 23 (b)**

Answers could include:

Convert heat of combustion for each fuel to kJ mol^{-1} or convert kJ mol^{-1} for 1-butanol to kJ g^{-1} .

Molar mass of 1-butanol = 74 g mol^{-1} or $\frac{2676}{74} = 36.2 \text{ kJg}^{-1}$ for 1-butanol

A $48 \times 74 = 3552 \text{ kJ mol}^{-1}$

B $38 \times 74 = 2812 \text{ kJ mol}^{-1}$

C $28 \times 74 = 2072 \text{ kJ mol}^{-1}$

Due to loss of energy to environment and other factors such as impurities in the fuel and heat conductivity issues, the resultant heat of combustion will be significantly lower than the published value of 2676 kJ mol^{-1} .

Assessment – the fuel from the table is most likely to be C.

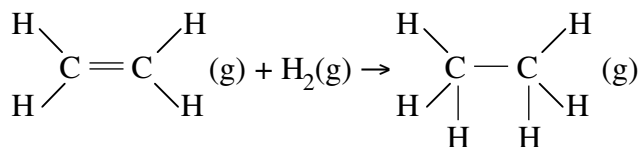
A has too high a value.

B has a value still higher than the published value.

C has a value that is lower than the published value.

Question 24 (a)

Sample answer:



Addition reaction.

Question 24 (b)

Answers could include:

Ethene will react with bromine water. The brown colour will disappear if any ethene remains. To test – add bromine water drop by drop to sample. The sample should turn brown if all the ethene has been converted.

Use of KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$ with appropriate explanation.

Question 25***Sample answer:***

Dissolved O_2 is the concentration of oxygen gas dissolved in a water sample. BOD is a value obtained by calculating the change in dissolved O_2 concentrations after 5 days. BOD is directly related to the amount of bacteria consuming O_2 during the decay of organic matter. Consequently the relationship between dissolved O_2 and BOD is necessary as BOD cannot be calculated without being able to measure the dissolved $[O_2]$.

It is important to measure both dissolved O_2 and BOD as the dissolved $[O_2]$ values allow for BOD value to be obtained. The BOD value is then used as a measure of microbial activity in water, which determines the quality of water.

Question 27***Sample answer:***

Anode Zn(s)

Cathode HgO(s)

Electrolyte KOH(aq)

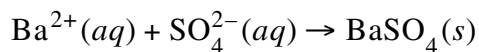
Question 28**Answers could include:**

1. STEP A: Na_2CO_3 should be initially dried and stored in a desiccator.
2. Dried Na_2CO_3 , 5.30 g, should be weighed out accurately (2 decimal places)
Mass of $\text{Na}_2\text{CO}_3 = 0.1 \times 0.5 \times 105.99$
3. 500 ml volumetric flask cleaned and rinsed with distilled water. Weighed Na_2CO_3 added to volumetric flask, using funnel and washed in using distilled water. Add distilled water to the flask to mark, with bottom of the meniscus.
4. STEP B: Clean, rinse, and fill a 50 ml burette with the unknown acid and place on a retort stand.
5. Clean a 250 ml conical flask and rinse with distilled water.
6. Clean a 25 ml pipette and rinse with 0.1 M Na_2CO_3 solution. Fill pipette with Na_2CO_3 solution to mark with bottom of meniscus.
7. Add pipette volume into conical flask. Add suitable indicator to the conical flask. Place a white tile under the conical flask.
8. Slowly add acid solution from the burette into the conical flask. When indicator changes colour, record the final volume. This initial titration should be taken as a rough test. Three more titrations should be performed with the average titration being used for calculations.
9. STEP C: $2\text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{H}_2\text{CO}_3(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
10. moles of $\text{Na}_2\text{CO}_3 = 0.1 \times 0.025$
 $= 2.5 \times 10^{-3}$
11. moles of HCl = $2 \times$ moles of Na_2CO_3
 $= 5 \times 10^{-3}$
12. Concentration of HCl = $\frac{\text{moles of HCl}}{\text{vol of HCl}}$
 $= \frac{5 \times 10^{-3}}{21.4 \times 10^{-3}}$
 $= 0.234 \text{ mol L}^{-1}$

Question 29 (a)**Answers could include:**

Assumptions made include:

- Accurately weighed
 - No loss of material in dissolving, filtering, rinsing
 - All sulfate reacted with Ba^{2+} ($\therefore \text{Ba}^{2+}$ added in excess)
 - Reaction goes to completion
 - All BaSO_4 precipitated (very low solubility of BaSO_4 means that a very small amount is dissolved)
 - No loss of BaSO_4 in filtration process
 - All precipitate dried completely and correctly weighed.
 - With careful and precise laboratory techniques, errors can be minimised in weighing, filtering, rinsing and drying
 - Loss of BaSO_4 in precipitation is considered negligible
- \therefore Method is justified.

Question 29 (b)**Answers could include:** SO_4^{2-} content calculated to be 35% (by mass)

$$\begin{aligned}\therefore \text{Mass of } \text{SO}_4^{2-} &= \frac{35}{100} \times 4.25 \text{ g} \\ &= 1.4875 \text{ (1.49) g}\end{aligned}$$

$$\begin{aligned}\therefore \text{Moles } \text{SO}_4^{2-} \text{ present} &= \frac{1.4875}{96.07} \\ &= 0.01548 \text{ moles } \text{SO}_4^{2-} \quad (0.0155)\end{aligned}$$

 \therefore Moles BaSO_4 present is also = 0.01548

$$\begin{aligned}\text{Mass } \text{BaSO}_4 &= 0.01548 \times 233.37 \\ &= 3.6134 \text{ g} \quad (3.6172 \text{ g})\end{aligned}$$

$$= 3.61 \text{ g} \quad (3.62 \text{ g})$$

Question 30 (a)

Answers could include:

	<i>Polymerisation of ethylene</i>	<i>Polymerisation of glucose</i>
Type of reaction	Addition	Condensation
Feature of reaction	Breaking double bonds	Releases a water molecule for each glucose unit added
Equation	$ \begin{array}{c} \begin{array}{c} & \\ -C & = & C- \\ & \end{array} + \begin{array}{c} & \\ -C & = & C- \\ & \end{array} + \begin{array}{c} & \\ -C & = & C- \\ & \end{array} \\ \downarrow \\ \begin{array}{c} & & & & & \\ -C & - & C & - & C & - & C & - & C & - & C & - & C- \\ & & & & & \end{array} \end{array} $	$ \begin{array}{c} HO-\square-OH + HO-\square-OH + HO-\square-OH \\ \downarrow \\ \begin{array}{c} \square-O-\square-O-\square \\ \downarrow \quad \downarrow \\ H_2O \quad H_2O \end{array} \\ HO-\square-OH \text{ represents a glucose molecule} \end{array} $

Question 30 (b)

Answers could include:

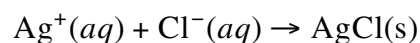
<i>Polymer</i>	<i>Structure</i>	<i>Property</i>	<i>Use</i>
LDPE (low density polyethylene)	Cross links between polymer chains	Less dense, softer, lower melting point	Glad wrap, garbage bags
HDPE (high density polyethylene)	No cross links, molecules packed closer together	Denser, harder, higher melting point	Pipes, buckets
Starch	Glucose units arranged in same orientation	Partly soluble	Energy food for living things
Cellulose	Glucose units arranged alternately	Insoluble	Support structures for most plants, food for some animals

- Diagrams acceptable for structure
- Can be given in a table but there must be a link between the structure, properties and uses for each polymer

Question 31 (a) (i)**Sample answer:**

$$\text{Mass of TDS} = (44.67 - 43.53) = 1.14 \text{ g}$$

$$\begin{aligned} \% \text{TDS} &= \frac{1.14}{250} \times \frac{100}{1} = 0.456\% \\ &= 0.46\% \text{ (2 sig. fig.)} \end{aligned}$$

Question 31 (a) (ii)**Answers could include:**

Addition of silver ions to form a visible white precipitate.

OR Pb^{2+} , Hg^{2+} **Question 31 (b)****Answers could include:** Na^+ Tidal movements allow the inflow of Na^+ ions into fresh water streams causing the salination of a waterway.

Or

Cations	Cu^{2+} / Mg^{2+} / Pb^{2+} from mining
	Ca^{2+} / Mg^{2+} from geological work
Anions	NO_3^- / PO_4^{3-} from agriculture or industry

Section II

Question 32 – Industrial Chemistry

Question 32 (a)

Sample answer:

The Mercury Cell

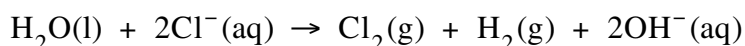
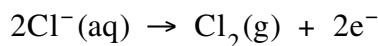
NaCl(aq) enters the cathode compartment where the Na⁺ ions are reduced to Na. The sodium dissolves in the mercury to form a sodium amalgam. This amalgam is then sprayed with water in the Decomposer to produce a chemical reaction that forms the desired NaOH(aq) and bi-products H₂(g) and Hg(l). The mercury does not react with water and can be recycled. The hydrogen is removed and the aqueous sodium hydroxide can be collected.

Question 32 (b)

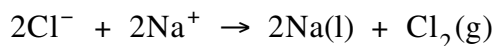
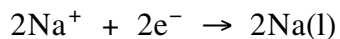
Sample answer:

Electrolysis of molten and aqueous NaCl both require an external energy source to drive the reaction. Molten NaCl is pure NaCl in the liquid state, whereas aqueous NaCl is a mixture of NaCl and water. In both cells Cl⁻ ions are eventually oxidised to Cl₂(g). Na⁺ ions are reduced to liquid Na in molten NaCl electrolysis, whereas in the aqueous electrolysis water is reduced in preference to the Na⁺ ions. Molten NaCl requires more energy input to drive the reaction than electrolysis of aqueous NaCl.

Aqueous electrolysis

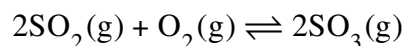


Molten electrolysis



Question 32 (c) (i)

Answers could include:



Initial mol	0.8	0.4	–
Equilibrium	0.5	0.25	0.3
[]	0.05	0.025	0.03

$$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]}$$

$$\begin{aligned} K_c &= \frac{(0.03)^2}{(0.05)^2 (0.025)} = \frac{9 \times 10^{-4}}{6.25 \times 10^{-5}} \\ &= 14.4 \\ &= 14 \end{aligned}$$

Question 32 (c) (ii)

Sample answer:

A decrease in temperature of the reaction vessel causes a shift in the equilibrium so that new concentrations of SO_2 and SO_3 are produced, giving a different equilibrium constant. Only a temperature change can cause a change in equilibrium constant value. (The new calculated value is not required).

Answers could include:

Non-spiking of the graph indicates that equilibrium change is not due to sudden changes in pressure/volume or concentration

Question 32 (d) (i)

Sample answer:

Saponification
Potassium hydroxide (KOH)

Question 32 (d) (ii)**Sample answer:**

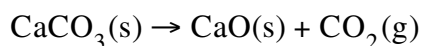
Method: Accurately weigh out 10 g of oil. Carefully measure a mass of KOH that is required to react in the mole ratio of the oil being used. Mix the reactants with a stirring rod. Add boiling chips and gently heat while still stirring the mixture. Heat for 30 minutes or until soap curds are visible. Remove from heat and allow to cool. Add saturated NaCl solution to 'salt out' the soap. Filter through cotton wool and rinse lightly with distilled water to remove any excess alkali. Crude soap can then be collected.

Precautions: Perform experiment in a clean, dry workspace. When using an alkali, wear protective clothing. As the mixture may spit during heating, goggles should be worn to protect the eyes. Heat gloves could be worn when handling hot glassware. If a methylated spirit mixture is being used to assist dissolution of the fat/alkali mixture then care should be taken with the presence of a flammable solution near the naked flame of a Bunsen burner. A hotplate could be used to limit the danger but care should be taken as burns from a hotplate could occur. Finally the prac should take place in a well-ventilated area and the crude soap product should not be tested on your skin as excess alkali could still be present.

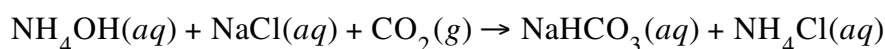
Question 32 (e)**Answers could include:**

Limestone has the chemical formula CaCO_3 . The CaCO_3 is important for the Solvay Process as it is a raw material necessary for the production of CaO and CO_2 which are both necessary in other steps in the Solvay process.

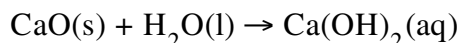
The CaCO_3 can be decomposed to $\text{CaO}(\text{s})$ and $\text{CO}_2(\text{g})$ by the use of thermal decomposition.



The resulting $\text{CO}_2(\text{g})$ is then reacted with the alkaline brine to produce sodium hydrogen carbonate and ammonium chloride.



The CaO (lime) also formed from the decomposition of limestone is reacted with water to form $\text{Ca}(\text{OH})_2(\text{aq})$



The $\text{Ca}(\text{OH})_2$ that is produced is eventually used in the ammonia recovery stage.

The use of limestone does result in environmental impacts.

Heating the limestone requires the use of large amounts of energy. The water used releases large amounts of thermal pollution that can have negative impacts on ecosystems as high temperatures can cause dissolved oxygen levels to be lowered.

The decomposition of limestone allows for the production of reactants useful in later stages in the Solvay Process.

This reduces negative environmental impacts as recycling of materials reduces the need for disposing of unnecessary wastes.

The production of CaCl_2 is a waste product and even this has alternative uses in drying agents, concrete additives and ice melting.

The excess CaCl_2 and Ca(OH)_2 do create issues in regards to finding areas for land fill where the material can be disposed.

In conclusion, the use of limestone in the Solvay Process is beneficial as it provides a source of chemicals necessary for use in later stages and limits the number of negative impacts on the environment.

Question 33 – Shipwrecks Corrosion and Conservation

Question 33 (a)

Sample answer:

Artefact is made of wood and metal. Marine environments mean that salt water has permeated wood fibres into the spaces around the cells. Some cellulose may have been hydrolysed by the action of fungal or bacterial decomposers. Metal components will have been affected by corrosion due to salinity, oxygen, bacteria or low pH. If 2 metals were involved there would have been a galvanic reaction where the more active metal has been oxidised.

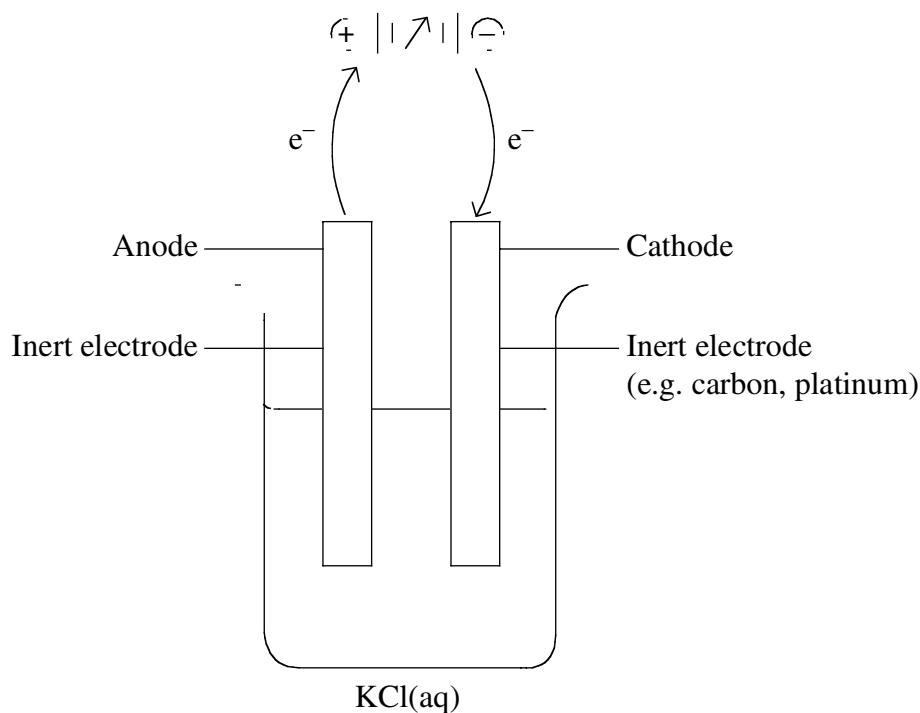
Answers could include:

Sound answers must include both wood and metal and mention effects of long-term immersion in a marine environment specific to each material.

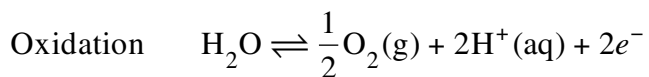
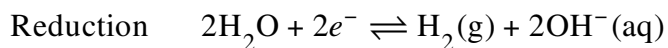
Other materials appropriate to the time are acceptable eg leather.

Question 33 (b) (i)

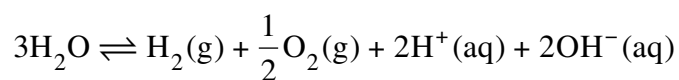
Sample answer:



Half equations



Overall equations


Question 33 (b) (ii)

Sample answer:

Hydrogen gas is produced at the cathode. Collect a sample and use the pop test to identify it as hydrogen.

Question 33 (c)**Sample answer:**

<i>Steel</i>	<i>Properties</i>	<i>Uses</i>
1	Soft, malleable, easily welded, corrodes easily – low carbon content	Car bodies, roofing, nails, wire, pipes
2	Hard, brittle, corrodes readily – high carbon content	Axe head, small tools, springs, scissors
3	Hard, less ductile, corrodes rapidly – high carbon content with Si	Girders, rail tracks, axles, forgings
4	Resists corrosion, hard, high tensile strength – presence of Cr and Ni	Kitchen sinks, surgical instruments, cutlery, razor blades

Answers could include:

Any appropriate property or use that is associated with a steel.

Question 33 (d) (i)**Sample answer:**

Iron samples (eg nails) can be tested in a school laboratory in three different environments – temperature variations, salinity variations, oxygen concentration variations. Each nail can be placed in a test tube and compared to the relevant control for signs of corrosion. Students may prefer to use a table with environmental conditions, control and results included.

Answers could include:

One other factor is pressure. If considered, must use a test that can be reliably performed in a school laboratory.

Question 33 (d) (ii)**Sample answer:**

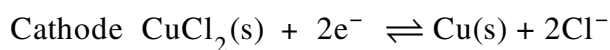
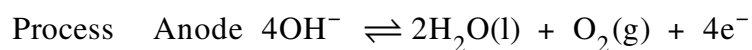
Temperature, pressure, O₂ concentration, salt concentration.
Protection – paints, polymer coatings, galvanising, sacrificial anodes, applied voltage, use of corrosion-resistant materials, cathode protection

Answers could include:

Any correct method of protection.

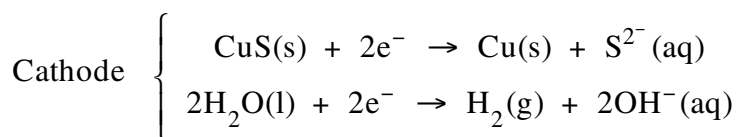
Question 33 (e)
Sample answer:

	<i>Restoration</i>	<i>Preservation</i>
Wooden artefact	Cleaning (mud, rust, sediment, calcareous deposits). Keep moist to avoid salt crystallisation. Fungicides	Spray wood with PEG (polyethylene glycol) to reinforce cellular structure. Cover with clear acrylic or wax
Copper artefact	Soak in weak acid bath to remove calcium carbonate. Use electrolysis to remove copper sulphide or copper chloride with correct half equation.	Coat in clear acrylic or microcrystalline wax

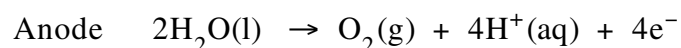


Copper chloride

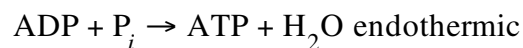
OR



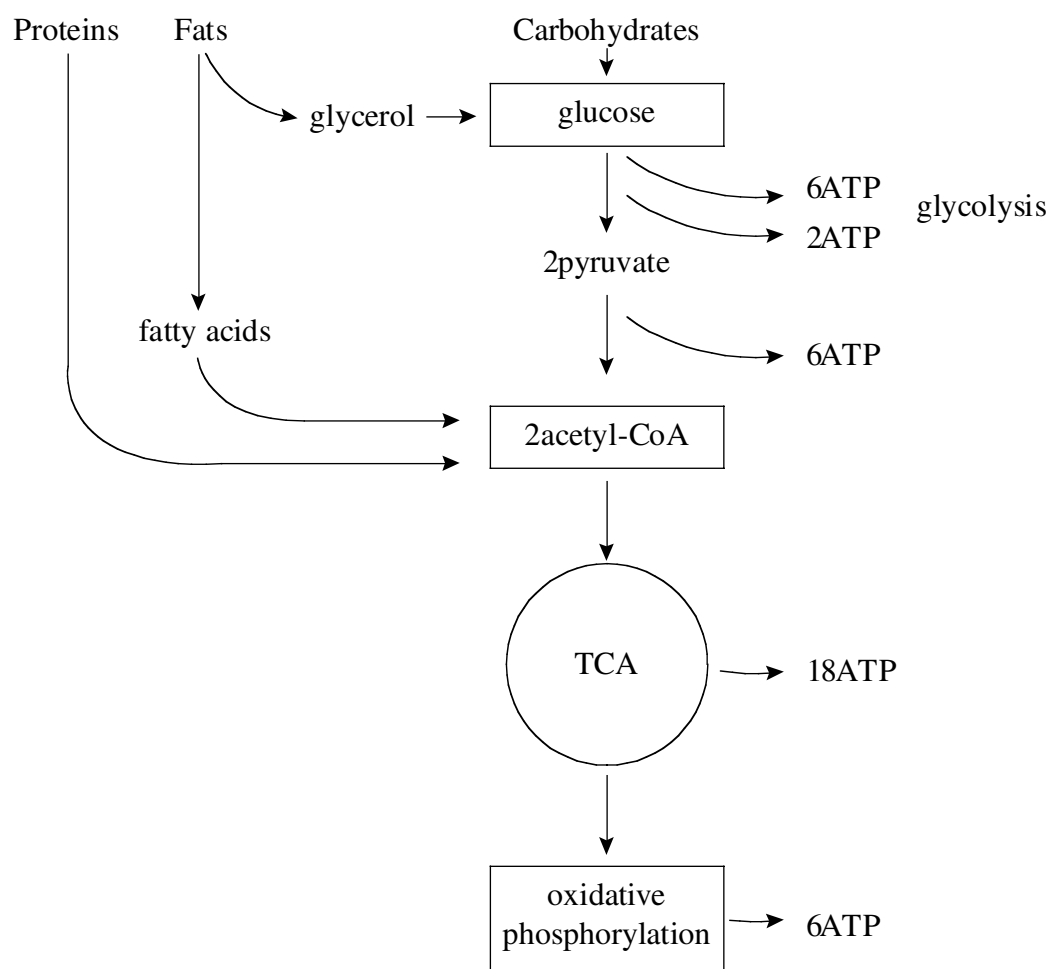
Copper sulfide


Question 34 (a)
Sample answer:

ADP – adenosine diphosphate



ADP is essential in the formation of ATP where energy is stored. This results in a high-energy bond. When ATP is hydrolysed the energy released is used for cellular processes and ADP is regenerated.

Question 34 (d)*Sample answer:*

Question 34 (e)***Sample answer:***

Skeletal muscle is made from two types of protein: thick filaments or myosin and thin filaments or actin. Muscle contraction requires ATP and calcium ions. The calcium ions interact with part of the muscle and this allows the myosin to catalyse the hydrolysis of ATP, resulting in the release of energy.

At the cellular level there are two types of cells.

Type 1 Cells – slow twitch cells or fibres. These cells have an adequate blood supply and therefore a plentiful supply of oxygen for aerobic respiration. They have many mitochondria and get much of their ATP from oxidative phosphorylation. Type 1 cells are therefore ideal for use in sustained exercise. The top distance athletes usually have a highly developed ability to utilise these cells from consistent training of this type. All forms of food can supply energy for their needs.

Type 2 cells, however, contract rapidly. They have fewer mitochondria and therefore reduced blood supply and less available oxygen. These cells are used in fast events such as ‘sprints’ or short-course swimming where maximum energy is required quickly. Available glucose is metabolised anaerobically. Stored glycogen can also be utilised. Anaerobic respiration results in the production of lactic acid which can result in muscle soreness and cramping.

Athletes usually undertake a specific training regime to maximise the ability of the body to take in and use oxygen. Part of this program includes the incorporation of a diet that is high in carbohydrates prior to their events.

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

Most electronegative element in period 3 is chlorine (Cl). The electronegativity is a measure of an atom’s ability to attract electrons to itself.

Electronegativities increase across periods in the periodic table from left to right or as the number of valence electrons increases. Fluorine is the most electronegative element with all other electronegativities relative to this.

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

Chelating ligand

Answers could include:

Chelate

Chelating agent

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

Cu^{2+} complex ion, $[\text{Cu}(\text{oxalate})_2]^{2-}$ with oxalate is coloured.

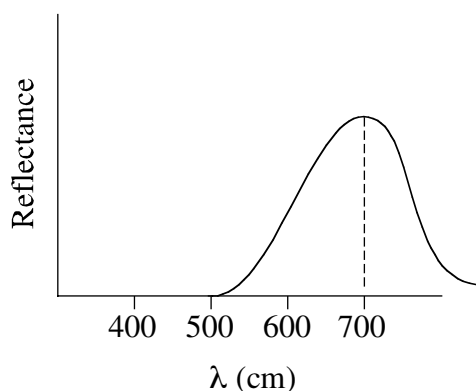
Cu^+ complex ion, $[\text{Cu}(\text{oxalate})_2]^{3-}$ with oxalate is colourless.

Cu^{2+} has 9 electrons in its d orbitals, which allows for an electron to be excited (absorb visible light) to a higher vacant energy level. This results in the observed colour of the Cu^{2+} complexes.

Cu^+ has 10 electrons in its d orbitals, which is the full complement of electrons in the d orbitals. Therefore no electron transitions to high energy levels is possible. Therefore complexes of Cu^+ are colourless.

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

The wavelength at which the reflectance is a maximum is 700 nm. Therefore the pigment must be red.

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

Infra-red radiation covers wavelengths between 700 nm and 1 mm within the electromagnetic spectrum. Near infra-red lies closest to 700 nm and is commonly called 'cool' infra-red. Far infra-red is longer wavelengths and is commonly called 'hot' infra-red. Infra-red reflectography is commonly used for the identification and analysis of pigments.

IR is particularly good for detecting underdrawing where carbon-based compounds have been used, such as graphite pencils, charcoal or black ink. Copper based pigments also strongly absorb in the IR.

Care must be taken when 'hot' IR is used, due to possible damage to pigments and or artwork. IR reflectography is a non-destructive method of analysis.

Question 35 (d)***Sample answer/Answers could include:***

The Bohr model of the atom describes the orbit of electrons around the nucleus at fixed radii and energy.

The emission line spectrum of hydrogen was seen to support the Bohr model as discrete lines were observed which could be assigned to electronic transitions between fixed energy levels. However when the emission line spectrum for sodium was recorded there were more spectral lines than could be explained by the Bohr model. Line splitting or doublets were observed. The line splitting or doublets result from electrons having differing angular momenta, residing in sub-shells, which was not considered in the Bohr model.

Question 35 (e)***Answers could include:***

Common components of cosmetics used by ancient cultures which presented health risks include lead (Pb), mercury (Hg), arsenic (As), antimony (Sb) and copper (Cu). Compounds containing one or more of these elements may show acute toxicity, immediate symptoms, if ingested in large amounts. However, the same compounds can cause chronic toxicity, or long-term toxicity if prolonged exposure at low levels occurs. In general prolonged exposure to low levels of toxic chemicals resulted from the use of pigments for cosmetics purposes in ancient cultures.

Examples of compounds used by ancient cultures as cosmetics and their health risks were given below.

<i>Cosmetic</i>	<i>Name</i>	<i>Chemical Name</i>	<i>Formula</i>	<i>Health Risks</i>
Rouge lipstick	Cinnalow Vermillion	Mercury Sulfide	HgS	Highly toxic if ingested Can cause central nervous system damage Kidney disease
Face powder	White lead	Basic lead carbonate	PbCO ₃ , Pb(OH) ₂	Toxic if ingested Can cause brain damage in children Skin and eye irritant

Question 36 (a)*Sample answer:*

A	B
<ul style="list-style-type: none">• Starch• Long chain twisted into a spiral• Made by plants	<ul style="list-style-type: none">• Glycogen• Branching chains• Made by animals

Answers could include:

B could alternatively be amylopectin made by plants.

Question 36 (b) (i)*Answers could include:*

- Amino acids are placed on the centre line of a tray of gel at a particular pH
- An electrical potential is applied across the tray (positive at the top in the diagram)
- Amino acids move at a rate dependent on their charge and molecular weight
- Because the charge on the amino acid depends on the pH, the movement of the amino acids depends on the pH.

Question 36 (b) (ii)*Answers could include:*

Y is valine – does not move at pH 6 therefore must be neutral, X and Z are both charged at pH 6.

Moves up at pH 8 when it is negative. Top of the tray is therefore positive.

X is lysine – moves down at pH 6 and pH 8 are therefore must be positive at both pHs.

Z is glutamic acid moves up at both pH 6 and pH 8 therefore must be negative at both pHs.

Moves up quicker at pH 8 because it has a double negative charge instead of the single negative charge at pH 6.

Question 36 (c) (i)*Sample answer:*

Manufacturer B

Question 36 (c) (ii)***Answers could include:***

- In excited gaseous atoms electrons absorb energy and move from the ground state to higher energy shells in the atom.
- When electrons return to a lower energy shell they emit a discrete amount of energy dependent on the energy difference between the two shells.
- This energy released corresponds with a particular wavelength of light.
- In different elements electrons are moving between different shells (or sub-shells) producing light with a unique set of wavelengths for each element.
- The spectrum for the unknown pottery matches the spectrum for copper and mercury but not the other three metals.

Question 36 (d) (i)***Answers could include:***

- colour
- pH
- % organic content
- % sand or % clay or ratio sand:clay
- mineral analysis of any sand or salt grains present
- insects or other invertebrates present
- significant pieces of plant material present
- pollen analysis
- tests for specific ions eg sulfates, chlorides, calcium.

Question 36 (d) (ii)***Answers could include:***

Organic test: % organic matter

- Gently warm soil to remove water
- Weigh
- Heat strongly in an oven to burn off organic matter
- Re-weigh
- Calculate % organic matter.

Inorganic test: grainsize analysis

- Heat the soil strongly to burn off the organic matter
- Perform a grainsize analysis with sieves or settling column
- Calculate the % of different-sized particles from sand to clay.

Question 36 (e)***Answers could include:***

- Sample of DNA is put through a process called polymerase chain reaction (PCR) to make many copies of the original DNA. This involves repeatedly heating and cooling them to separate strands of DNA, add bases and then reform the DNA strands.
- Sample of DNA is then added to a specific mixture of restriction enzymes to cut the DNA at specific locations or markers.
- Different people have different lengths of DNA between these markers because of the presence of introns or 'junk DNA' between genes.
- The pieces of DNA are put through electrophoresis to separate them. They are placed in the centre of a gel plate and an electric field is applied across the plate.
- The distance travelled by the particular piece of DNA in the electrophoresis depends on its size. This will be different in different people.
- By combining the results for different pieces of DNA a unique individual profile is obtained.
- Some of the uses of DNA are:
 - establishing presence or absence of a suspect at a crime scene
 - establishing paternity
 - providing prehistoric evidence of human ancestry e.g. for the movement of people across the world
 - establishing relatedness between animals as evidence for evolution.
- Some uses may be controversial, eg privacy issues associated with establishing DNA data banks.