NSW INDEPENDENT TRIAL EXAMS – 2009
CHEMISTRY TRIAL HSC EXAMINATION
MARKING GUIDELINES

Section I – Part A

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

Section I – Part B

16(a)

Criteria	Marks
Ethylene is obtained by the catalytic cracking of longer chained fractions of petroleum. These hydrocarbons are heated strongly in the absence of air but in the presence of a catalyst. The carbon chains are broken into shorter chain lengths. Continued cracking ultimately results in the formation of ethylene.	2

16(b)

Criteria	Marks
$CH_2 = CH_2 + H_2O \longrightarrow CH_3CH_2OH$ The catalyst used is dilute sulfuric acid.	2

16(c)

Criteria	Marks
Ethanol can be dehydrated to form ethylene. $CH_3CH_2OH \longrightarrow CH_2 = CH_2 + H_2O$ This reaction can be performed in the presence of a strong dehydrating agent such as concentrated sulfuric acid. Ethanol can be obtained by the fermentation of sugars from renewable sources such as sugar cane. $C_6H_{12}O_6 \longrightarrow 2\ CH_3CH_2OH + 2\ CO_2$ The use of non-renewable petroleum resources can be reduced by obtaining ethylene via the dehydration of ethanol formed by fermentation using renewable resources of sugars.	3

17

Criteria	Marks
Alkenes contain a reactive double bond in their carbon chain and so readily react with bromine in aqueous solution. The double bond opens up allowing bromine atoms to bond with the carbon atoms in an addition reaction. eg $CH_2 = CH_2 + Br_{2\ (aq)} \longrightarrow CH_2BrCH_2Br$ Alkanes have only single bonds between carbon atoms. Hence, in the absence of UV light, bromine in aqueous solution does not react with alkanes. Bromine water is a yellow/brown colour due to the presence of the Br_2 molecules. When the Br_2 reacts with alkenes, the bromine water loses its colour. This allows the fact that a reaction has occurred to be easily identified. In the presence of alkanes, bromine water retains its yellow/brown colour as there is no reaction. Bromine water is therefore most suitable for the purpose of distinguishing between alkanes and alkenes as it readily undergoes an easily identified reaction with alkenes but does not react with alkanes.	5

18(a)

Criteria	Marks
Atoms of zinc are ionised and accelerated to very high speeds in a particle accelerator before smashing into a lead target. If the zinc nuclei have sufficient energy to overcome repulsive forces, they combine with lead nuclei forming a superheavy element such as 112.	2

18(b)

Criteria	Marks
This type of research increases our understanding of the structure of the atomic nucleus and may produce new isotopes for use in areas such as industry and medicine.	2

19

Criteria	Mark
The chemical reactions that take place in a battery involve electron transfer between oxidant and reductant species. These reactions can be considered as separate oxidation (electron loss) and reduction (electron gain) reactions. Electrons from the reductant are transferred to the oxidant during the reactions. In the construction of a battery, these two processes are physically separated so that the electrons must move through an external circuit for the transfer to take place, allowing usable electrical energy to be generated. In the battery, the oxidant and reductant are separated by a barrier that allows ions to move through it to complete the electrical circuit and thus keep the two sides of the battery electrically neutral. The reductant forms the anode or negative terminal of the battery, while the oxidant forms the cathode or positive terminal.	3

20(a)

Criteria	Marks
$CO_{2(g)} + 2OH^- \rightarrow CO_3^{2-} + H_2O$ (or molecular form with 2NaOH) $Ca^{2+} + CO_3^{2-} \rightarrow CaCO_{3(s)}$	2

20(b)

Criteria	Marks
Mole mass of $CaCO_3$ = 40 + 12 + 48 = 100 g ∴1000 kg = 10,000 moles Moles of CO_2 needed = 10,000 moles ∴Volume of CO_2 needed = 10,000 x 24.79 = 247,900 L Volume of air to pass through "tree" = 247,900 / 0.00038 = 6.52×10^8 L	1 1

20(c)

Criteria	Marks
1000 kg $CaCO_3$= 10,000 moles ∴180 kJ mol^{-1} x 10,000 moles = 1.8×10^6 kJ energy required 1.8×10^6 kJ / 1 000 kJ mol^{-1} = 1.8×10^3 mol natural gas ∴V = 1.8×10^3 mol X 24.79 L mol^{-1} = 4.46×10^4 L natural gas needed	1 1

21(a)

Criteria	Marks
In the reaction magnesium atoms are oxidised to form magnesium ions, showing that it is an oxidation-reduction reaction. Carbon atoms are reduced in the reaction (from +2 to 0).	1 1

21(b)

Criteria	Marks
The monomeric tetrafluoroethylene is a low boiling substance (non-polar and low molecular mass) and chemically reactive owing to its double C=C bond.	1
The polymer is a plastic which is stable and unreactive, as it has no multiple bonds, making it much more suitable for packing into a flare canister.	1

22(a)

Criteria				Marks
	Start Point (mL)	**End Point (mL)**	**Vol H_2SO_4 (mL)**	1
	0.0	18.6	**18.6**	
	18.6	37.3	**18.7**	
	12.8	31.5	**18.7**	
		Mean Volume:	**18.7**	

22(b)

Criteria	Marks
Moles NaOH = 2 x moles H_2SO_4 or $C_bV_b = 2 \times C_aV_a$	1
$25 \times 0.220 = 2 \times 18.7 \times C_a$ and $C_a = 0.147$ mol L^{-1}	
Concentration of $H_2SO_4 = 0.147$ mol L^{-1}	1

22(c)

Criteria	Marks
Initial Moles $H_2SO_4 = 0.5 \times 0.25 = 0.125$ mol	1
Moles used to dissolve Mg = 0.125 – moles remaining = 0.125 – 0.0735 = 0.0515 mol	
Moles of Mg = moles H_2SO_4 =0.0515 mol Mass of Mg = $0.0515 \times 24.31 = 1.251965$ g	
$\therefore$ Percentage of Mg by mass = $1.251965 \times 100/2.12 = 59.05\%$ (59.1% to 3 sf.)	1

22(d)

Criteria	Marks
A 25.0 mL pipette is used.	1

22(e)

Criteria	Marks
A measured mass of flare mixture is reacted with sulfuric acid under an inverted measuring cylinder, initially filled with water. After equalising water levels the volume of hydrogen gas collected is measured and converted to moles, using the molar volume of a gas under collection conditions. As one mole of Mg produces one mole of hydrogen, the mass of magnesium can be determined.	2

23(a)

Criteria	Marks
CH_3CH_2OOCH (in expanded form showing all bonds).	1

23(b)

Criteria	Marks
• Small quantities (approximately equimolar) of ethanol and formic acid are mixed together in a boiling flask • A little concentrated sulfuric acid is added. • The flask is connected vertically to a condenser. • The mixture is boiled under reflux.	2

23(c)

Criteria	Marks
The isomeric compound is propanoic acid. (formula $C_3H_6O_2$).	1
Propanoic acid will change the colour of an acid-base indicator, such as litmus. Ethyl formate has no acid-base properties. (or any other weak acid property such as effervescence of CO_2 with a carbonate)	1

24(a)

Criteria	Marks
Phosphorus is present as phosphate ion, and iron (III) ion forms a precipitate of iron(III) phosphate. $Fe^{3+} + PO_4^{3-} \rightarrow FePO_{4(s)}$.	1
It is important to remove the phosphate ion from the effluent to minimise fertilising action, which would promote growth of aquatic plants and eutrophication.	1

24(b)

Criteria	Marks
Any one of chlorine, ozone or UV irradiation.	1
The purpose is to destroy bacteria by strong oxidation (or UV exposure) to ensure no harmful pathogenic bacteria are present in the effluent.	1

24(c)

Criteria	Marks
Add excess dilute silver nitrate solution to a 100 mL sample of the effluent. Separate the silver chloride precipitate by filtration, dry and weigh the solid.	1
$Ag^+ + Cl^- \rightarrow AgCl_{(s)}$	1
The mass and concentration of chloride ion can be calculated from the formula AgCl.	1

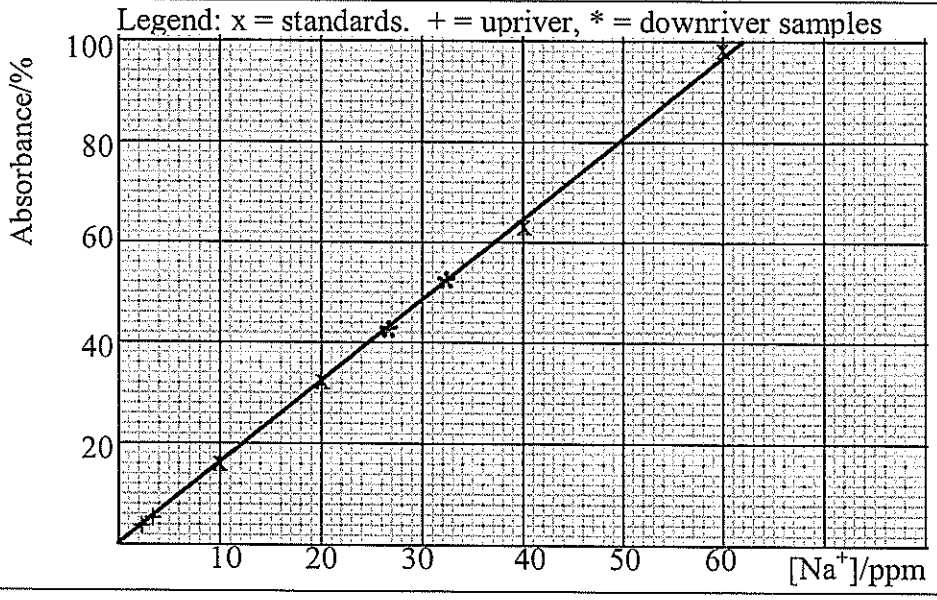
25(a), (b)

Criteria — **Marks**

Solution	Na^+ Concentration (mg L^{-1})	Absorbance at 589 nm(%)	
Standard	10	16	
Standard	20	34	
Standard	40	63	
Standard	60	98	
Upriver sample 1	2.5	4	
Upriver sample 2	3.2	5	
Downriver Sample 1	32.5	54	
Downriver sample 2	26.5	43	

Marks: 2

(a)

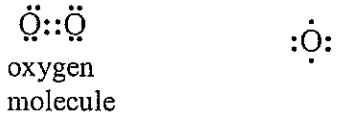


Marks: 3

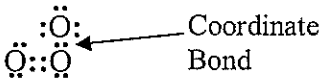
25(c)

Criteria	Marks
These downriver sodium concentrations are within safe limits for freshwater organisms. During low rainfall periods the river flow will decrease, reducing the dilution effect. As a result the downriver sodium concentrations will increase, possibly above the maximum level.	2

26(a)

Criteria	Marks
 oxygen molecule :Ö: The oxygen free radical is much less stable than the oxygen molecule	2

26(b)

Criteria	Marks
An oxygen free radical combines with an oxygen molecule by means of a coordinate covalent bond.  Coordinate Bond	2

Section II

Question 27 – Industrial Chemistry

Q 27(a)

Criteria	Marks
Sodium hydroxide is produced by the electrolysis of brine, a concentrated solution of sodium chloride in water. The sodium chloride is obtained by evaporation of seawater. In the modern membrane electrolytic cell, the brine is electrolysed using a titanium anode and steel mesh cathode, supporting a membrane which separates the electrolyte into anode and cathode compartments. The membrane allows sodium ions to pass through to the cathode, where water is reduced to hydrogen gas and hydroxide ions. $H_2O + e^- \rightarrow \frac{1}{2}H_{2(g)} + OH^-$ The solution of sodium hydroxide is collected as it passes through the steel mesh cathode and is then concentrated or obtained as the solid by evaporation. The anode reaction produces chlorine by oxidation of chloride ions. $Cl^- \rightarrow \frac{1}{2}Cl_{2(g)} + e^-$ Sodium hydroxide is a white waxy solid which is extremely soluble in water. It is a very strong base, and is the most widely used alkali in industry. Domestically it is used in drain and oven cleaners, for its ability to dissolve fatty deposits by the saponification reaction. Saponification is also the largest industrial use. It is used in the process of soap-making, where sodium hydroxide is used to convert fats and oils to soap and glycerol. A soap is a mixture of the sodium salts of fatty acids.	7

Q 27(b)(i)

Criteria	Marks
For the reaction $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$ $K_p = [SO_3]^2 \div ([SO_2]^2 [O_2]) = 626^2 \div (223^2 \times 114) = 0.069$	2

Q 27(b)(ii)

Criteria				Marks
Property	Total pressure	Kp	Yield of SO_3	2
Graph (A,B,C,orD)	A	C	D	

Q 27(b)(iii)

Criteria	Marks
At 25°C the reaction would be extremely slow and it would take millions of years to reach equilibrium.	1

Q 27(c)(i)

Criteria	Marks
Three endothermic reactions are: 1. Decomposition of calcium carbonate: $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ 2. Ammonia recovery: $Ca(OH)_2 + 2NH_4Cl \rightarrow 2NH_{3(g)} + CaCl_2 + 2H_2O$ 3. Production of sodium carbonate $2NaHCO_{3(s)} \rightarrow Na_2CO_{3(S)} + CO_{2(g)} + H_2O_{(g)}$	3

Q 27(c)(ii)

Criteria	Marks
The most suitable fuel is natural gas which is easily transported by pipeline, has a high heat of combustion and burns cleanly, producing less carbon dioxide than other fossil fuels such as coal.	2

Q 27(d)

Criteria	Marks
Soap is a mixture of sodium salts of long chain fatty (carboxylic) acids. Each anionic molecule consist of a long non-polar alkyl chain which is hydrophobic and a highly polar and negatively charged carboxyl group which is strongly hydrophilic.  Mixed with water soap molecules form clusters called micelles forming an emulsion. Each micelle has a non-polar interior comprising alkyl groups and a surface layer of polar hydroxyl groups which form hydrogen bonds with water molecules. Grease and other non-polar molecules and are dissolved into the non-polar interior of the micelles, hence the cleansing effect of soap.	2 2

Q 27(e)

Criteria	Marks
A galvanic cell produces energy while an electrolytic cell consumes energy. In a galvanic cell an exothermic chemical reaction occurs to create a voltage and deliver current and energy to an external circuit. e.g. electrodes of copper and magnesium immersed in a potassium nitrate solution. The magnesium anode is oxidised to magnesium ions while water is reduced to hydrogen at the copper cathode.	2
An electrolytic cell can be made of stainless steel electrodes in a sodium chloride solution. An external voltage source drives current through the cell. Water is reduced at the cathode and the chloride ion is oxidised to chlorine at the anode.	2

Question 28 – Shipwrecks, Corrosion and Conservation

Q 28(a)

Criteria	Marks
Steel-hulled ships operate in a strongly oxidising environment in which seawater provides a highly conducting electrolyte for electrochemical corrosion. Oxygen in the atmosphere, and dissolved in the surface layers of the ocean, is the principal oxidising agent, and all metals are reducing agents. Iron, the most widely used metal is a strong reductant in this situation, initially undergoing oxidation to iron(II) ions. $Fe_{(s)} \rightarrow Fe^{2+} + 2e^-$	7

Question 28(a) continues on the next page

Question 28(a) continued

The primary reduction reaction, which occurs on a suitable cathodic surface, is of oxygen to hydroxide ion. $\frac{1}{2} O_2 + H_2O + 2e^- \rightarrow 2OH^-$ The ultimate product is hydrated iron(III) oxide, or rust. Measures taken to combat corrosion include: 1) Preventing contact of the seawater with the steel using impervious coatings such as grease, paint or a passivating metal. 2) Cathodic protection by embedding slabs of a more reactive metal which becomes a sacrificial anode. In this situation the steel becomes a cathode and oxidation of iron is prevented. Using an inert metal such as titanium, an external voltage can be applied from the ship's generators to make the steel hull a cathode in the cell so created. 3) Use of passivating metals, such as aluminium alloys, in place of steel for fittings and superstructure can also reduce the problem of corrosion. 4) Taking care to prevent contact of seawater with less active metals or alloys, such as copper and bronze, which act as cathodes and accelerate the electrochemical corrosion of steel.	

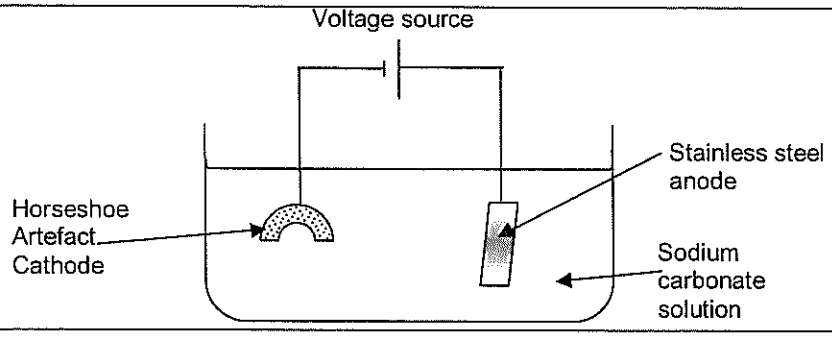
Q 28(b)(i)

Criteria	Marks
Together with salt spray the copper plate and galvanised bracket create an electrochemical cell in which the bracket is the anode. Corrosion of the bracket is accelerated due to contact with the copper, with both zinc and iron being oxidised to 2^+ ions, while oxygen is reduced at the copper cathode. Iron(II) ions then react with oxygen to form a deposit of rust.	3

Q 28(b)(ii)

Criteria	Marks
If sufficiently strong for the purpose a plastic bracket could be used, such as high density PVC, which is unreactive. Otherwise a passivating metal such as stainless steel or titanium could be used. These metals develop a tough and impervious oxide layer, which minimises or prevents corrosion under these conditions.	2

Q 28(c)(i)

Criteria	Marks
	2

Q 28(c)(ii)

Criteria	Marks
Anode: $2OH^- \rightarrow \frac{1}{2}O_{2(g)} + H_2O + 2e^-$ or $H_2O \rightarrow \frac{1}{2}O_{2(g)} + 2H^+ + 2e^-$ Cathode: e.g., $Fe_2O_{3(s)} + 3H_2O + 6e^- \rightarrow 2Fe_{(s)} + 6OH^-$ or $Fe^{3+} + 3e^- \rightarrow Fe_{(s)}$	2

Q 28(c)(iii)

Criteria	Marks
When reduction of rust to iron is complete the cathode reaction becomes the reduction of water producing bubbles of hydrogen gas.	1

Q 28(d)

Criteria	Marks
Three iron nails were placed in a sodium chloride solution containing an indicator for the presence of iron(II) ions (e.g., potassium hexacyanoferrate(III)). The first nail was wrapped with a spiral strip of magnesium ribbon and the second with bare copper wire. The third nail was left bare. After a short time the indicator changed to blue around the second and third nails showing corrosion was occurring. Corrosion was much more rapid for the nail wrapped in copper wire. Corrosion took place mostly at the ends of the bare nail where the metal had been stressed. There was no observable corrosion of the first nail, however a white suspension of magnesium hydroxide formed, showing that sacrificial protection was occurring. The magnesium acted as an anode, with the iron becoming a cathode in the galvanic cell formed.	4

Q 28(e)

Criteria	Marks
Volta followed up Galvani's work with frog's legs and showed that the electrical stimulus came from a combination of two different metals (brass and iron) in contact with the frog's leg. This led him to investigate different electrochemical cells. He invented the voltaic pile, or battery to gain increased voltage. The pile consisted of discs of zinc and silver or copper with cardboard separators soaked in brine. Faraday used Volta's batteries to investigate electrolysis and the relationship between the electric current of electrochemical cells and the chemical reactions at the electrodes. He discovered the quantitative laws of electrolysis and introduced terminology such as anode, cathode and electrolyte.	4

Question 29 – The Biochemistry of Movement

Q29(a)

Criteria	Marks
Provides a comprehensive description of the formation and importance of glycogen. Provides an accurate illustration of glycogen and glucose.	7
Provides a description of the formation and importance of glycogen. Provides an accurate illustration of glycogen and glucose.	5-6
Provides a basic outline of the formation and importance of glycogen. Provides a rudimentary illustration of glycogen and glucose.	3-4
Provides some relevant information.	1-2

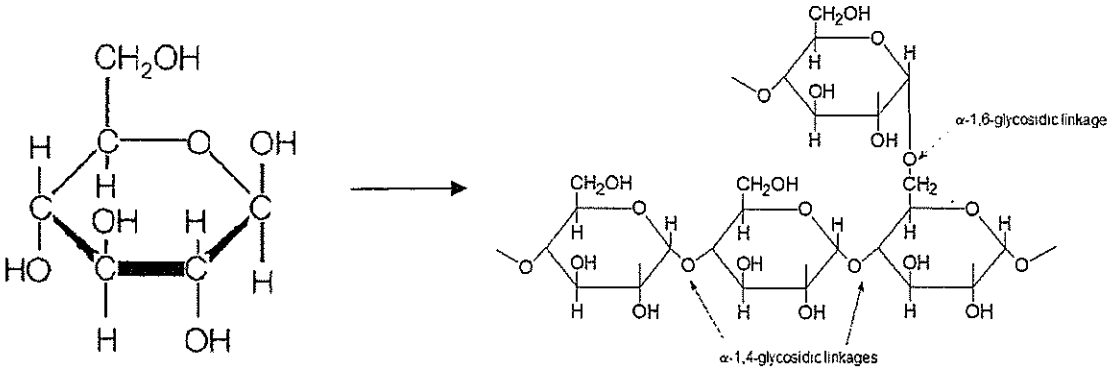
Answer may include:

- Glycogen is a condensation polymer formed from glucose through glycogenesis.
- Initially glucose is converted to Glucose-6-phosphate by glucokinase or hexokinase.

Question 29(a) continues on the next page

Question 29(a) continued

- Glucose-6-phosphate is then converted to glucose-1-phosphate by phosphoglucomutase
- Glycogen formation is endergonic which means it requires the input of energy.
- The energy for glucose synthesis comes from UTP which reacts with Glucose-1-phosphate to form UDP-glucose. This reaction is catalysed by UDP-glucose pyrophosphorylase.
- Glycogenin initiates the synthesis of glycogen from the UDP-glucose monomers and the glycogen synthase enzyme then adds UDP-glucose monomers to the glycogen chain.
- A branching enzyme forms branches off the glycogen chain.
- The bonds joining the glucose monomers are either 1,4 glycosidic (long chains) or 1,6 glycosidic bonds (branches).



- Glycogen is stored primarily in the liver and skeletal muscle. Glycogens function is to store glucose or energy in a reserve that is able to be rapidly mobilised when required.
- Glycogen is a much larger molecule than fat which is another form of energy storage; however its highly branched structure allows it to be rapidly broken down when required.
- Liver glycogen is responsible for maintaining blood glucose and muscle glycogen is utilised during exercise.

Q29(b)

Criteria	Marks
Provides a comprehensive description of the relationship between the chemical features of a protein and its shape. Uses a relevant example to illustrate answer.	5
Provides a description of the relationship between the chemical features of a protein and its shape. Uses a relevant example to illustrate answer.	3-4
Provides some information about the relationship between the chemical features of a protein and its shape.	1-2

Answer may include:

- An amino acid contains a carboxyl end, an amine end, and an organic part known as an R group.
- The peptide bond is between the amine group of one amino acid and the carboxyl group of another.
- A chain of amino acids linked by peptide bonds is a protein.
- When a protein is formed, certain interactions can influence the shape of the protein molecule.
- The R groups can form bonds with other amino acid R groups in the protein.
- Ionic bonds can form between oppositely charged side groups.
- R groups with O or N atoms can for hydrogen bonds to other R groups. Hydrogen bonds can also form between C=O and N-H groups in the protein backbone.
- Dispersion forces can cause the formation of spiral helices, which exclude water.
- Disulfide bonds can form between two cysteine residues forming a strong covalent bond.
- All these factors cause the protein to bend and fold to form a unique shape.

½ mark per point

Q29(c)

Criteria	Marks
Provides an accurate outline of the ATP production involved in sprinting.	3
Provides some relevant information about the ATP production involved in sprinting.	1-2

Answer may include:

- When sprinting, muscles quickly use ATP.
- Heavy breathing indicates a need for oxygen for oxidative decarboxylation and oxidative phosphorylation.
- As the creatine phosphate supply last for approximately 5 seconds when sprinting and it takes much longer for the oxygen breathed in to reach the muscle cells and replace the ATP though aerobic respiration, the sprinting muscles must use a non-oxygen (anaerobic) ATP production method.
- The method used is anaerobic glycolysis, which converts pyruvate to lactic acid, which is transported out of the cell in the blood stream. This allows for the regeneration of NADH without using oxygen.
- The muscles can thus continue to convert one glucose to two pyruvate and release two ATP.
- As the lactic acid concentration increases in the blood, raising the pH, this process cannot continue.

½ mark per point

Q29(d)

Criteria	Marks
Provides an accurate outline of the role of oxygen in respiration.	3
Provides some relevant information about the role of oxygen in respiration.	1-2

Answer may include:

- In the metabolism of glucose, glycolysis is the first step. This is where the glucose is converted to pyruvate.
- The pyruvate is then able to go down one of two separate paths.
- If the oxygen supply is insufficient the pyruvate is fermented to lactic acid. This has a net production of 2 ATP, and enables the NADH to be regenerated for reuse.
- If there is oxygen present then the pyruvate will form acetyl-CoA and enter the TCA and eventually the electron transport chain.
- This process produces much more ATP (approximately 36 more than glycolysis alone).
- With oxygen as the terminal electron acceptor, NADH and $FADH_2$ are able to be oxidised and thus regenerated.

½ mark per point

Q29(e)

Criteria	Marks
Provides a comprehensive description of the process of muscle contraction	5
Provides a description of the process of muscle contraction	3-4
Provides some information about the process of muscle contraction	1-2

Answer may include:

- Nerve cells stimulate the release of calcium ions.
- An electrical impulse is transmitted from nerves to the cell membrane of the muscle fibre.
- The impulse carried throughout the muscle cell causes the release of calcium ions as the impulse passes.
- The calcium ion concentration increases by ten times and the calcium binds with troponin causing a conformation change in tropomyosin which is released from the myosin binding site on the actin filament. This allows the myson to bind the actin.
- The myosin hydrolyses ATP to ADP and Pi.
- The ATP energy is released as mechanical energy where the actin filaments are pulled past the myosin filaments.
- The actin and myosin filaments slide past each other and overlap more.
- The bonds between actin and myosin are temporary and are released when the calcium ion concentration decreases, causing the muscle to relax.
- During the contraction the myosin and actin filaments do not change length.
- The myosin is attached to the Z disk via titin and when sliding over the actin causing shortening of the sarcomere.

½ mark per point

Q29(f)

Criteria	Marks
Provides appropriate equations summarising the reduction/oxidation process in ATP regeneration. Refers to both electron carriers.	2
Provides appropriate equations summarising the reduction/oxidation process in ATP regeneration. Refers to one electron carrier.	1

Answer may include:

$NADH + H^+ + 3\ ADP + 3\ Pi + {}^1/_2O_2 \rightarrow NAD^+ + 3\ ATP + H_2O$

$FADH_2 + 2\ ADP + 2\ Pi + {}^1/_2O_2 \rightarrow FAD + 2\ ATP + H_2O$

Question 30 – Chemistry of Art

Qu 30(a)

Criteria	Marks
Bohr proposed a model of the hydrogen atom with the electron occupying one of a limited set of circular orbits centred on the nucleus. Each available orbit has its own radius and energy value, with higher energy orbits being further from the nucleus. To move to a higher orbit the electron has to absorb energy. When an electron drops to a lower orbit it emits energy as a quantum of light. The Bohr model accounted for the main emission (and absorption) lines in the hydrogen spectrum, and was the first to apply quantum ideas to atomic structure. However, it did not explain why orbits were restricted and was unable to account for the spectra of multi-electron atoms, or the more detailed structure of the hydrogen spectrum. Worse, the Bohr atom could not exist as an orbiting electron must continually radiate energy and the atom would collapse. More detailed spectral studies and ionisation measurements have led to a more elaborate wave mechanical model for the atom with each principal quantum (or energy) level being divided into sets of sublevels. Bohr's circular orbits have been replaced by three-dimensional regions called orbitals which are probability distributions for the location of the electron. The Pauli exclusion principle limits the number of electrons at each level, sublevel and orbital by stating that no two electrons can have exactly the same state. Together with Hund's Rule that electrons occupy the lowest available energy levels this provides a model for all atoms of the Periodic Table. Each block in the table corresponds to the completion of a sublevel. Each period commences with a 's' sublevel; Group 1 & 2 block to the 's' sublevels, Groups 3-8 to the 'p' sublevels and the transition series to the 'd' sublevels. The rare earths and actinides for the remaining blocks and correspond to the filling of 'f' sublevels.	7

Qu 30(b)(i)

Criteria	Marks
The unknown pigment will appear red-yellow in reflected light.	2

Qu 30(b)(ii)

Criteria	Marks
Titanium oxide shows high (100%) reflectance across the entire visible spectrum, providing the opacity needed of a paint pigment. Zinc oxide has high reflectance which extends into the near ultraviolet A region and reduces the exposure of skin cells to damaging UV radiation from the sun.	2

Qu 30(b)(iii)

Criteria	Marks
Of these four pigments only zinc oxide shows reflectance extending into the UVA region and then only to a wavelength of around 360 nm. Zinc oxide provides the best, but incomplete, protection.	1

Qu 30(c)

Criteria	Marks
Microspectral analysis (MSA) is a very sensitive and reliable method for identifying the origin of paint samples. It is able to detect the presence of elements at extremely low concentrations, and only requires a very small sample for analysis. MSA involves the vaporisation and atomisation of a small sample of material using an intense ultraviolet laser. The atoms are produced in an excited state and emit their characteristic emission spectrum. By comparing the spectrum produced to the spectra of known elements, the elements present in the sample can be identified. Key lines in the spectrum produced can be used to identify the elements and their relative concentrations in the sample. Motor vehicle paints use a mixture of metal oxides as pigments and each paint batch has a unique combination of oxides, even for pigments of the same colour. Thus MSA can not only identify the metals present but also the batch of paint used on the vehicle.	5

Qu 30(d)

Criteria	Marks
Copper(II) ion has 27 electrons, with the structure $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7\ 4s^2$. The anhydrous copper ion is colourless as there are no electronic transitions corresponding to the quantum energies of visible light. When the copper ion is hydrated, water molecules contribute pairs of electrons into the valence shell and new electronic energy levels are created. Some of these absorb light quanta at long (red) wavelengths in the visible region and a blue colour results.  Similarly, in high chloride ion concentrations, chloride ions form coordinate covalent bonds with the copper ion. With different ligands the energy levels are also changed and a different set of wavelength is absorbed, leading to a green colour.	4

Qu 30(e)

Criteria	Marks
A paint consists of a mixture of pigments suspended as an emulsion in a liquid carrier, commonly water or an oil such as linseed oil. The coloured pigments used in paints are often oxides or other compounds of transition metals, where the colour of the pigment depends upon the identity of the metal, its oxidation state and bonding to other elements. For example chromium(III) oxide is a blue-green colour while iron(III) oxide varies from yellow to orange-red. In higher oxidation states chromium can exhibit a range of colours from deep blue to orange and the chromate(III) ion is bright yellow. As transition metals have varied oxidation states and associated colours, they can be combined in mixed pigments to produce a vast range of colours. Some transition metals are toxic and of these some are unable to be excreted form the body and are cumulative toxins. Examples are compounds of lead and mercury, once used as common pigments, now banned for general use. Cinnabar, mercury(II) sulfide, was once popular for its bright orange colour and was used for facial decoration, as was lead acetate known as white lead.	4

Question 31 – Forensic Chemistry

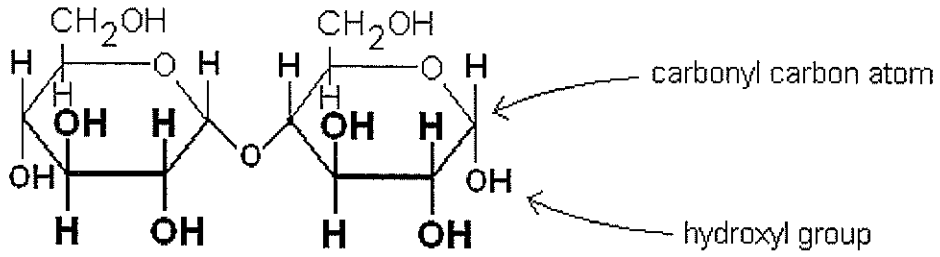
Q 31(a)

Criteria	Marks
Atomic emission spectroscopy (AES) is a very sensitive and reliable method for identifying the origin of soil samples. It is able to detect the presence of elements at extremely low concentrations, and only requires a very small sample for analysis. Soil is a complex mixture of organic and inorganic material. Soils from different locations can differ greatly in colour, texture, pH and chemical composition, including in the concentration of many of the trace elements. Measurements of many of the physical properties of small samples of soil cannot be done accurately. However, the production and analysis of a line emission spectrum of even a tiny soil sample can detect the presence of some of the less common chemical elements in the soil. Each element has its own characteristic set of energy levels in its atoms and so will produce a unique set of coloured lines in its line emission spectrum. By comparing the spectrum produced to the spectra of known elements, the elements present in the sample can be identified. Comparison of the presence and concentration of the less common elements in the soil sample with soil from known locations can determine if the soil matches. In larger samples of soil, the use of AES can help confirm matches of soil samples made comparing other physical properties.	7

Q 31(b)(i)

Criteria	Marks
The molecular formula for maltose, $C_{12}H_{22}O_{11}$ [or $C_{12}(H_2O)_{11}$] fits the general formula for a carbohydrate $C_x(H_2O)_y$.	1

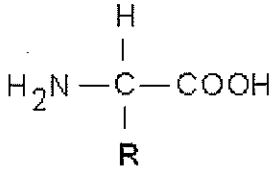
Q 31(b)(ii)

Criteria	Marks
Maltose is a reducing sugar as it has a hydroxyl group (-OH) attached to the carbonyl atom in one of the ring structures.  	2

Q 31(b)(iii)

Criteria	Marks
Sugars are made of one, two or three monosaccharide units joined together. Starch is made of 1000's of monosaccharide units joined together. Sugars made of more than one monosaccharide unit, and starch can be hydrolysed to form monosaccharides.	2

Q 31(c)(i)

Criteria	Marks
All amino acids contain an amine functional group ($-NH_2$) and a carboxylic acid functional group (-COOH) in their molecules and have the following general structure  where R represents a hydrogen atom or a carbon containing side chain. Different amino acids have a different R group.	1

Q 31(c)(ii)

Criteria	Marks
Electrophoresis is able to identify amino acids by using an applied electric field to separate them according to differences in their molecular mass and charge. A sample of the mixture to be analysed is spotted on a piece of porous paper or gel alongside samples of separate pure amino acids for comparison. The paper or gel is soaked in an electrolytic solution containing a suitable buffer. When a voltage is applied across the paper or gel, positive ions will migrate in one direction; negative ions migrate in the opposite direction while neutral ions remain stationary. The speed of migration depends on the molecular mass – smaller less massive molecules move faster. The charge on the amino acids depends on its isoelectric point and the pH of the electrolytic buffer. At the isoelectric point, the amino acids exist as neutral ions. They will be negatively charged at pH's well above this isoelectric point and positively charged at pH's well below. Electrophoresis is a very effective and reliable method for identifying the composition of a mixture of amino acids. Each amino acid has a unique combination of molecular mass and isoelectric point. By repeating the analysis at different pH's all amino acids can be separated. The components of the mixture of amino acids can be identified by comparison with the pure amino acid samples run along side the sample being analysed. Each amino acid will move at a unique speed, allowing each component to be separated and analysed.	4

Q 31(d)(i)

Criteria	Marks
An alkanol will react with sodium metal to produce hydrogen gas. e.g. $C_2H_5OH_{(l)} + Na_{(s)} \longrightarrow C_2H_5ONa + \frac{1}{2} H_{2(g)}$ A hydrocarbon does not react with sodium metal.	2

Q 31(d)(ii)

Criteria	Marks
When heated in air, an organic compound will react with oxygen to produce carbon dioxide gas. e.g. $C_5H_{12(l)} + 8\ O_{2(g)} \longrightarrow 5\ CO_{2(g)} + 6\ H_2O_{(l)}$ An inorganic compound will not produce carbon dioxide gas when heated in air.	2

Q 31(e)

Criteria	Marks
DNA carries the genetic code that determines all of the inherited characteristics of a living organism. Because all humans have a large number of characteristics in common, over 99% of a person's DNA will be identical to that of another person. Each DNA molecule contains thousands of genes, each gene separated from the next by a "non-coding" sequence of bases called introns. These introns vary significantly from one person to the next making each person's DNA unique. DNA analysis allows the comparison of DNA from different samples to establish whether they came from the same person or from different people. The huge number of possible intron combinations means that the chances of unrelated people having matching DNA is one in many billion. Matches of DNA can then be considered a very reliable method for identifying individuals. 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.	4

NSW INDEPENDENT TRIAL EXAMS – 2009
CHEMISTRY HSC TRIAL EXAMINATION
MAPPING GRID

Question	Marks	Content	Target performance bands
1	1	9.2.4	3-4
2	1	9.2.5	3-4
3	1	9.2.3	4-5
4	1	9.2.1, 9.9.2	2-3
5	1	9.2.3	2-3
6	1	9.3.2,9.3.3	3-4
7	1	9.3.4	4-5
8	1	9.3.3	3-4
9	1	9.3.4	3-5
10	1	9.3.4	3-4
11	1	9.3.2	2-3
12	1	9.4.4	3-4
13	1	9.4.2	3-5
14	1	9.4.3	4-5
15	1	9.4.4	3-4
16(a)	2	9.2.1	3-4
16(b)	2	9.2.3	2-4
16(c)	3	9.2.2, 9.2.3	2-4
17	5	9.2.1	3-6
18	4	9.2.5	3-5
19	3	9.2.4	2-5
20(a)	2	9.3.2, 9.4.3	2-4
20(b)	2	9.3.2	3-4
20(c)	2	9.3.2, 9.2.3	3-4
21(a)	2	9.2.4	3-5
21(b)	2	9.2.1	4-5
22(a)	1	9.3.4	2-3
22(b)	2	9.3.4	3-4
22(c)	2	9.3.4	4-5
22(d)	1	9.3.4	1-2
22(e)	2	9.1, 9.3.2	5-6
23(a)	1	9.3.5	3-4
23(b)	2	9.3.5	2-4
23(c)	2	9.1, 9.3.5	3-5
24(a)	2	9.4.2, 9.4.5	4-5
24(b)	2	9.4.5	3-5
24(c)	3	9.4.2,9.4.5	4-6
25(a)	3	9.1,9.4.3	3-5
25(b)	2	9.1,9.4.3	3-5
25(c)	2	9.4.5	4-5
26(a)	2	9.4.4	3-4
26(b)	2	9.4.4	3-5
27	25	9.5	2-6
28	25	9.6	2-6
29	25	9.7	2-6
30	25	9.8	2-6
31	25	9.9	2-6