2007 CHEMISTRY HSC TRIAL - Mapping Grid

Question	Marks	Content	Target performance band
1	1	9.4.3	2-4
2	1	9.2.1	2-4
3	1	9.2.4	2-4
4	1	9.3.5	2-4
5	1	9.3.5	2-4
6	1	9.3.4	2-4
7	1	9.3.4	2-4
8	1	9.4.4	2-4
9	1	9.3.2	2-4
10	1	9.4.3	2-4
11	1	9.3.5	2-4
12	1	9.4.2	2-4
13	1	9.2.3	2-4
14	1	9.3.5	2-4
15	1	9.3.5	2-4
16(a)	3	9.2.3	2-3
(b)	1	9.2.3	2-3
(c)	1	9.2.3	3-5
(d)	3	9.2.3	4-6
(e)	4	9.2.3	4-6
17(a)	2	9.2.4	2-4
(b)	2	9.2.4	2-4
(c)	2	9.2.4	3-5
(d)	2	9.2.4	3-5
18(a)	2	9.2.4	3-5
(b)	2	9.2.4	4-6
(c)	2	9.2.4	4-6
19(a)	1	9.3.3	2-4
(b)	2	9.3.3	3-5
(c)	2	9.3.3	3-5
(d)	2	9.3.3	3-5
(e)	3	9.3.3	4-6
(f)	1	9.3.3	4-6
20(a)	2	9.3.2	2-3
(b)	3	9.3.2	4-6
(c)	2	9.3.2	4-6
21(a)	3	9.4.2, 9.4.3	2-4
(b)	2	9.4.2, 9.4.3	2-4
(c)	2	9.4.2, 9.4.3	3-5
22(a)	1	9.4.4	2-3
(b)	3	9.4.4	2-3
(c)	2	9.4.4	4-6
23	3	9.4.3, 9.4.5	4-6

Question	Marks	Content	Target Performance Band
Question 24 – Industrial Chemistry			
(a)	7	9.5	2-6
(b)(i)	2	9.5	2-6
(ii)	2	9.5	2-6
(c)	5	9.5	2-6
(d)(i)	3	9.5	2-6
(ii)	3	9.5	2-6
(iii)	3	9.5	2-6
Question 25 – Shipwrecks, Corrosion and Conservation			
(a)	4	9.6	2-6
(b)(i)	1	9.6	2-6
(ii)	2	9.6	2-6
(c)(i)	3	9.6	2-6
(ii)	4	9.6	2-6
(d)(i)	2	9.6	2-6
(d)(ii)	2	9.6	2-6
(e)	7	9.6	2-6
Question 26 - Biochemistry of Movement			
(a)	1	9.7	2-6
(b)(i)	1	9.7	2-6
(ii)	1	9.7	2-6
(iii)	1	9.7	2-6
(iv)	1	9.7	2-6
(v)	1	9.7	2-6
(c)	3	9.7	2-6
(d)	2	9.7	2-6
(e)	2	9.7	2-6
(f)	3	9.7	2-6
(g)	3	9.7	2-6
(h)	3	9.7	2-6
(i)	3	9.7	2-6
Question 27 – Chemistry of Art			
(a)	6	9.8	2-6
(b)	2	9.8	2-6
(c)	4	9.8	2-6
(d)(i)	2	9.8	2-6
(d)(ii)	1	9.8	2-6
(d)(iii)	4	9.8	2-6
(e)(i)	2	9.8	2-6
(ii)	1	9.8	2-6
(iii)	1	9.8	2-6
(iv)	2	9.8	2-6
Question 28 – Forensic Chemistry			
(a)(i)	1	9.9	2-6
(a)(ii)	3	9.9	2-6
(b)(i)	2	9.9	2-6
(ii)	2	9.9	2-6
(iii)	4	9.9	2-6
(c)	7	9.9	2-6
(d)(i)	1	9.9	2-6
(ii)	5	9.9	2-6

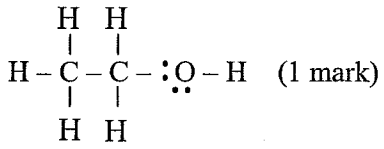
NSW INDEPENDENT TRIAL EXAMS – 2007
CHEMISTRY HSC TRIAL EXAMINATION
MARKING GUIDELINES

Section I

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

Section II

16(a)

Suggested Answers	Mark
 (1 mark) Ethanol has a highly polar hydroxyl group with the ability to form hydrogen bonds, similar to water. (1 mark) The non-polar CH_3CH_2 ethyl group is similar to the alkanes with weak intermolecular forces. (1 mark)	3

16(b)

Suggested Answers	Mark
Any ONE of the following – ethanol: ▪ has an unusually high boiling point, ▪ dissolves completely in water, ▪ dissolves polar solutes such as sugar.	1

16(c)

Suggested Answers	Mark
Either ONE of the following – ethanol ▪ dissolves in hydrocarbons, such as petrol. ▪ burns to form carbon dioxide and water.	1

16(d)

Suggested Answers	Mark
Renewable: from fermentation of glucose: $C_6H_{12}O_6 \xrightarrow[\text{enzymes}]{\text{yeast}} 2C_2H_5OH + 2CO_2(g)$ Non-renewable: by hydration of ethylene: $C_6H_4(g) + H_2O(g) \xrightarrow[\text{catalyst}]{\text{high pressure}} 2C_2H_5OH(g)$	3

16(e)

Suggested Answers	Mark
The main advantage is that ethanol is produced from renewable resources such as grain or sugar. This reduces our dependence on petroleum. It also burns more cleanly than hydrocarbons. (2 marks) Disadvantages include its lower energy content and the pressure on resources such as water and soil to grow the crops needed. The production of ethanol requires a higher energy input than fuels from petroleum. (2 marks)	4

17(a)

Suggested Answers	Mark
$Ag_2O(s) + Zn(s) + H_2O \rightarrow 2\ Ag(s) + Zn(OH)_2(s)$	2

17(b)

Suggested Answers	Mark
Cell voltage = 1.59 V. (1 mark) Steel cathode is positive. (1 mark)	2

17(c)

Suggested Answers	Mark
The porous barrier prevents direct contract between anode and cathode reactants (1 mark) and provides an ion bridge for ions to migrate, completing the cell circuit (1 mark).	2

17(d)

Suggested Answers	Mark
▪ The cell voltage will remain close to 1.59 V. This is because all reactants and products are solid with fixed concentration. (1 mark) ▪ The concentrate of hydroxide ions in solution is unchanged. (1 mark)	2

18(a)

Suggested Answers	Marks
${}^{238}_{94}Pu \rightarrow {}^{234}_{92}U + {}^{4}_{2}He$ ($\propto$ particle)	2

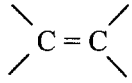
18(b)

Suggested Answers	Mark
Alpha radiation has very low penetration depositing concentrated energy and requiring no special shielding. Beta and gamma sources are more penetrating, require heavy shielding and may damage surrounding equipment.	2

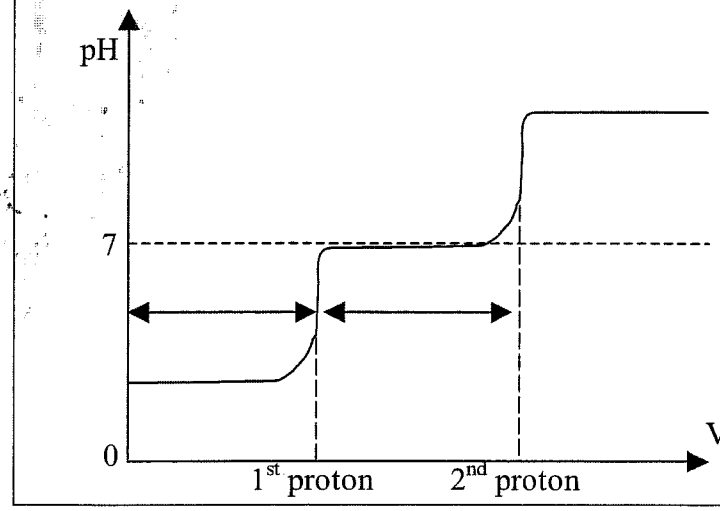
18(c)

Suggested Answers	Mark
The main risk is radiation exposure to workers handling the source and to the environment if a rocket failure occurs. Contamination of other planets into which the craft might fall is also a risk.	2

19(a)

Suggested Answers	Marks
The unit is a carbon - carbon double bond: 	1

19(b)

Suggested Answers	Marks
	2

19(c)

Suggested Answers	Marks
This is a weak acid and the neutralisation point is greater than 7 (see diagram above). Phenolphthalein has a range of pH 8 – 10 which detects this point.	2

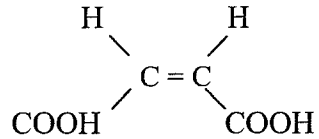
19(d)

Suggested Answers	Marks
What matters is the number of moles of acid and base. For the acid this is determined by the mass; the water volume is irrelevant. For the base the number of moles is determined by volume and concentration (CV), so volume must be measured accurately.	2

19(e)

Suggested Answers	Marks
Moles OH^- used = $20.9 \times 0.24 = 5.0 \times 10^{-3}$ mol 1 mole acid neutralises 2 moles OH^- Moles of acid = 2.5×10^{-3} Mole mass = 116 g $\therefore$ Molecular formula is $C_4H_4O_4$.	3

19(f)

Suggested Answers	Marks
Probable molecular structure is: 	1

20(a)

Suggested Answers	Marks
Carbon dioxide forms an equilibrium in water: $CO_2 + H_2O$ ($\rightleftharpoons$ H_2CO_3) $\rightleftharpoons$ $H^+ + HCO_3^-$ An increase in the CO_2 (aq) concentration drives the system to the right, increasing H^+ concentration and lowering the pH.	2

20(b)

Suggested Answers	Marks
Lower pH may affect the growth of some marine organisms which are sensitive to changes in acidity. Shells of invertebrates and corals are built from calcium carbonate which dissolves under acidic conditions. $CaCO_3(s) + H^+ \rightarrow Ca^{2+} + HCO_3^-$ Either these organisms may lose shell material or be unable to lay down new layers under acidic conditions.	3

20(c)

Suggested Answers	Marks
Carbon dioxide is removed in photosynthesis by marine plants and this process could be accelerated by extra CO_2, thus acting to reduce CO_2. $6CO_2 + 6H_2O \xrightarrow[\text{enzymes}]{\text{plant}} C_6H_{12}O_6 + 6CO_2(g)$ The ocean floor has extensive deposits of calcium carbonate in living and non-living structures and is itself buffered with dissolved carbonate and hydrogen carbonate ions. This will neutralise added H^+ ions in turn reducing dissolved CO_2. $CO_3^{2-} + 2H^+ \rightleftharpoons HCO_3^- + H^+ \rightleftharpoons CO_2 + H_2O$	2

21(a)

Suggested Answers	Marks
Phosphate ion is an essential plant nutrient. If the level of phosphate is too low food crops will grow poorly. If it is too high, unwanted plant growth occurs, especially in waterways where algal growth can block sunlight, leading to eutrophication, with low oxygen levels and high biological oxygen demand.	3

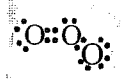
21(b)

Suggested Answers	Marks
In acid soils the $H_2PO_4^-$ ion will predominate as the equilibrium responds to higher hydrogen ion concentration. Conversely, in alkaline soils the HPO_4^{2-} is the main phosphate ion present.	2

21(c)

Suggested Answers	Marks
In the equilibrium shown HPO_4^{2-} is a base and $H_2PO_4^-$ is the conjugate acid. HPO_4^{2-} also acts as an acid: $HPO_4^{2-} \rightleftharpoons H^+ + PO_4^{3-}$ $H_2PO_4^-$ can act as a base: $H_2PO_4^- + H^+ \rightleftharpoons H_3PO_4$	2

22(a)

Suggested Answers	Marks
	1

22(b)

Suggested Answers	Marks
In the upper atmosphere ultraviolet light provides the energy of reaction for the production of ozone: $3O_2(g) \rightarrow 2O_3(g)$. In the lower atmosphere oxygen reacts with pollutants such as NO_x to produce ozone: $NO_x + O_2 \rightarrow O_3(g)$	3

22(c)

Suggested Answers	Marks
In the lower atmosphere ozone is a pollutant which is reactive, causes throat irritation and breathing problems and promotes photochemical smog. (1 mark) In the upper atmosphere ozone provides a vital shield by absorbing short wavelength ultraviolet light which is damaging to humans and other organisms. (1 mark)	2

23

Suggested Answers	Marks
Compared with polyethylene, biopolymers are more expensive, tear more easily and are less stable, especially when wet. The main advantage is that biopolymers are biodegradable while polyethylene, which is not, is a long-lasting pollutant.	3

Section II

Q24 Industrial Chemistry

Qu 24(a)

Suggested Answers	Marks
Sulfur dioxide gas is obtained by combustion of sulfur or the roasting of sulfide ores: $S(s) + O_2(g) \rightarrow SO_2(g)$. (1 mark) Sulfur dioxide and oxygen are passed over a platinum catalyst (or vanadium pentoxide) at moderate pressure and temperature to produce sulfur trioxide: $SO_2 + ½\ O_2 \rightleftharpoons SO_3(g)$. (2 marks) The forward reaction is exothermic and is favoured by low temperature and high pressure. However, the temperature must be high enough to reach equilibrium quickly. As well as monitoring the temperature and pressure in the reaction, the purity of the gases must also be monitored to avoid impurities which 'poison' the catalyst. (2 marks) As sulfur trioxide does not readily dissolve in water it is first dissolved in concentrated sulfuric acid to form pyrosulfuric acid: $SO_3(g) + H_2SO_4(l) \rightarrow H_2S_2O_7(l)$ $H_2S_2O_7(l) + H2O(l) \rightarrow H_2SO_4(l)$ (2 marks) The second reaction is strongly exothermic and must be performed under carefully controlled conditions.	7

Qu 24(b)(i)

Suggested Answers	Marks
Equilibrium concentrations (% by volume): $[CO_2] = [H_2] = 22\%$ $[CO] = [H_2O] = 28\%$ (1 mark) $K = \frac{[CO_2][H_2]}{[CO][H_2O]} = \frac{28^2}{22^2} = 1.62$ (1 mark)	2

Qu 24(b)(ii)

Suggested Answers	Marks
The forward reaction is exothermic so that a lower temperature increases the yield of H_2. Increasing the concentration of water (steam) and removing carbon dioxide (by absorption or liquefaction) increases the equilibrium yield of H_2.	2

Qu 24(c)

Suggested Answers	Marks
Saponification is the reverse of esterification and involves the breaking up (hydrolysis) of an ester. (1 mark) In esterification an acid and alcohol are combined to form an ester: acid + alcohol $\rightleftharpoons$ ester + water. A strong acid (e.g. H_2SO_4) is added to provide hydrogen ions which catalyse the reaction. A dehydrating agent (e.g. conc. H_2SO_4) is used to minimise water concentration, thus driving the equilibrium to the right. (2 marks) In saponification oil or fat (glyceryl triesters) are heated with sodium hydroxide solution. Hydroxide ions both catalyse the reaction and remove fatty acids (a product) by converting them to their salts (soap). Together with excess water the reaction proceeds almost 100% to hydrolyse the ester. (2 marks)	5

Qu 24(d)(i)

Suggested Answers	Marks
Material 1 is calcium carbonate obtained from deposits of limestone. Material 2 is sodium chloride obtained by evaporation of sea water.	3

Qu 24(d)(ii)

Suggested Answers	Marks
$H_2O + NH_3 + NaCl(aq) + CO_2 \rightleftharpoons NaHCO_3(s) + NH_4Cl(aq)$, OR $NH_4HCO_3(aq) + NaCl(aq) \rightleftharpoons NaHCO_3(s) + NH_4Cl(aq)$ (1 mark) The yield of $NaHCO_3$ is maximised by saturating concentrated brine with ammonia and carbon dioxide (high reactant concentrations), and using low temperatures at which the $NaHCO_3$ crystallises due to its low solubility.	3

Qu 24(d)(iii)

Suggested Answers	Marks
The waste is mainly calcium chloride solution from the regeneration of ammonia. (1 mark) The only acceptable disposal is by dilution into a large body of seawater, so the plant must be in proximity to the sea with sufficient tidal flushing to rapidly dilute the calcium chloride. (2 marks)	3

Q25 Shipwrecks, Corrosion and Conservation

Qu 25(a)

Suggested Answers	Marks
The origins of the minerals in the world's oceans come from two sources: the leaching by rainwater from terrestrial environments, and from hydrothermal vents in mid-ocean ridges. 1. Leaching by rainwater from terrestrial environments. Rainwater penetrates the rocks and soils, and then leaches out the minerals by the process of weathering. These mineral ions are carried down to the oceans and seas by the rivers and creeks. The main ions carried by the leaching of rainwater to the oceans are Na^+, Ca^{2+}, Mg^{2+}, Cl^-, $SO4^{2-}$, CO_3^{2-}. 2. The dissolution of salts by water passing through the hydrothermal vents in mid-ocean ridges. The seawater penetrates the cracks and fissures in the mid-ocean ridges. This hot water is forced back out through cracks called hydrothermal vents and as it does so this hot water dissolves the minerals in the rocks.	4

Qu 25(b)(i)

Suggested Answers	Marks
Manganese.	1

Qu 25(b)(ii)

Suggested Answers				Marks
$Mn(s)$	$\rightarrow$	$Mn^{2+} + 2e$	+1.18V	2
$Sn^{2+} + 2e$	$\rightarrow$	$Sn(s)$	-0.14V	
$Mn(s) + Sn^{2+}$	$\rightarrow$	$Mn^{2+} + Sn(s)$	1.04V	

Qu 25(c)(i)

Suggested Answers	Marks
Students can select any three types of steel. A suggested answer is as follows: 1. Mild Steel - has less than 0.2% Carbon , and is soft, malleable and has high tensile strength. It is used in car bodies, pipes, roofing and ship building. 2. Structural Steel - has 0.3 -0.6% Carbon, and is hard, malleable and has a high tensile strength. It is used in beams, girders, railways and reinforcment for buildings. 3. Stainless Steel - has 10 - 20% Cromium, 5 - 20% Nickel, and is hard, takes on a high polish and is resistant to corrosion. It is used in kitchen sinks and appliances, cutlery, surgical and dental instruments.	3

Qu 25(c)(ii)

Suggested Answers	Marks
Rusting occurs in the presence of oxygen and water. The site where iron oxidises to Fe^{2+} ions is the anodic site. The two electrons flow through the iron metal to a site where there is an impurity and this becomes the cathodic site. At the cathodic site the oxygen is reduced to hydroxide ions in a thin film of moisture on the iron surface or in the water if the iron is submerged. The reduction reaction is $O_2 + 2H_2O + 4e \rightarrow 4OH^-$. The Fe^{2+} and OH^- ions migrate through the moisture and forms insoluble $Fe(OH)_2$ i.e.: $Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$, The $Fe(OH)_2$ is oxidised to iron (iii) oxide... rust! i.e.: $4Fe(OH)_2 + O_2 \rightarrow 2Fe_2O_3.H_2O + 2H_2O$	4

Qu 25(d)(i)

Suggested Answers	Marks
Zinc metal electrode is the anode. Reference to the E_o Potential Table indicates that zinc's E_o value of -0.76V is higher (more negative) than iron's value of -0.44V meaning that Zinc will more readily lose electrons than iron and will be oxidised forming an anodic site.	2

Qu 25(d)(ii)

Suggested Answers	Marks
1. Bubbles of gas (O_2) forming around the location of the anode. 2. The copper metal is deposited at the cathode i.e.: brown/pink deposits on the carbon.	2

Qu 25(e)

Suggested Answers	Marks
Galvani showed that the muscles of a frog twitched when two different metallic wires were joined at one end, and the free ends placed on the exposed muscle. He thus became the first person to create an electric cell, and showed the electrical nature of the nerve muscle action. Volta showed that the electric effect came from the two wires in a solution and made the first galvanic cell, and using a pile of tin and copper plates with salt soaked cardboard in between them demonstrated that electrons could be readily transferred. He increased the voltage by joining cells in series, forming a battery. Davy used Volta's battery to perform electrolysis experiments, decomposing water and many other substances, including melted NaOH and KOH, obtaining these metals for the first time. Davy demonstrated that electrons deposited metals. Faraday developed the idea of current as a flow of electric charge, made accurate measurements of the electric charge and masses of substances formed in electrolysis, and put forward the laws of electrolysis.	7

Q26 The Biochemistry of Movement

Qu 26(a)

Suggested Answers	Marks
ATP.	1

Qu 26(b)(i)

Suggested Answers	Marks
Glycolysis.	1

Qu 26(b)(ii)

Suggested Answers	Marks
Glucose.	1

Qu 26(b)(iii)

Suggested Answers	Marks
Cytoplasm.	1

Qu 26(b)(iv)

Suggested Answers	Marks
Pyruvate or pyruvic acid or 2-oxopropanoate.	1

Qu 26(b)(v)

Suggested Answers	Marks
Two ATPs. Four are produced but 2 are consumed in this metabolic process.	1

Qu 26(c)

Suggested Answers	Marks
▪ Protein denaturation is the loss of function of a protein. ▪ Can be caused by changes of shape of the protein. ▪ The loss of the shape is caused by disruption of the bonds between the side chains such as breaking of ionic bonds, H-bonds or disulfide bonds (between cystine residues) (loss of 2°and 3° structure) Change in pH may cause a loss of charge of carboxyl groups, destroying ionic bonds. ▪ Increased temperature (increase of kinetic energy) may disrupt bonds and cause denaturation.	3

Qu 26(d)

Suggested Answers	Marks
▪ Fatty acids are oxidised to form acetyl CoA. ▪ Fatty acid oxidation occurs by successive removal of 2C fragments. ▪ This process leaves a fatty acid chain with two less carbons. ▪ This happens until the whole chain is broken down. ▪ The two carbon fragments are used in the acetyl part of the acetyl CoA molecule.	2

Qu 26(e)

Suggested Answers	Marks
$NADH + H^+ + 3ADP + 3P_i + ½O_2 \rightarrow NAD^+ + 3ATP + H_2O$ $FADH_2 + 2ADP + 2P_i + ½O_2 \rightarrow FAD + 2ATP + H_2O$.	2

Qu 26(f)

Suggested Answers	Marks
▪ During muscle contraction, glucose can either be fully oxidised to carbon dioxide and water or fermented to lactic acid. ▪ The oxidation requires oxygen while the fermentation does not. ▪ If oxygen is available the pyruvate produced in glycolysis is converted to acetyl CoA; if oxygen is not available then the pyruvate is fermented to lactic acid. ▪ The acetyl CoA is fully oxidised to carbon dioxide and water in the presence of oxygen. (this is known as aerobic respiration which produces much more ATP then Anaerobic respiration, which takes place in the lack of oxygen). ▪ Aerobic respiration is slow but releases lots of ATP; anaerobic respiration is fast but produces relatively little ATP. ▪ Anaerobic respiration cannot continue for long as the lactic acid builds up and lowers the pH of the cell. ▪ Aerobic respiration is used by type 1 muscles used in gentle exercise. Anaerobic respiration is used by type 2 muscles involved in strenuous exercise e.g. sprinting.	3

Qu 26(g)

Suggested Answers	Marks
▪ Amino acids join together by peptide bonds in polymer chains called polypeptide chains. The amino group of one amino acid joins to the carboxyl group of another. The positive charge of he amino group is attracted to the negative charge of the carboxyl group. ▪ This reaction releases a water molecule and is called a dehydration synthesis reaction or a condensation reaction. 	3

Qu 26(h)

Suggested Answers	Marks
▪ Oxidative phosphorylation is the process that couples the oxidation of NADH and $FADH_2$ to the production of ATP. ▪ Oxidation of $NADH + H^+$ and $FADH_2$ to NAD^+ and FAD. At the same time the energy in these electron carriers is transferred (electron transport chain) via cytochromes to ADP to form ATP. The phosphorylation step is the formation of the high energy bonds of ATP. ▪ Theoretically, per molecule of glucose 38 ATP's are able to be synthesised. 34 of these are produced via oxidative phosphorylation using NADH and $FADH_2$.S	3

Qu 26(i)

Suggested Answers	Marks
Myosin hydrolyses ATP to ADP and inorganic phosphate. ATP provides the mechanical energy to move the actin along the myosin. The myosin catalyses the breakdown of ATP as it binds to actin.	3

Q27 The Chemistry of Art

Qu 27(a)

Suggested Answers	Marks
Aboriginal art used mainly colours from the red-orange-yellow range in addition to black and white, reflecting the range of minerals available from their surroundings. Yellow ochre, limonite, and red ochre, haematite, are forms of hydrated iron (III) oxide and provide colours ranging from bright yellow, through orange to deep red. Kaolin clay was the main white pigment used and is hydrated potassium aluminium silicate; gypsum, hydrated calcium sulfate was also used. For black, both graphite, as charcoal, and powdered pyrolusite, manganese (IV) oxide, were used. These minerals are available at many locations throughout Australia, although people would travel large distances for rarer forms, especially the ochres.	6

Qu 27(b)

Suggested Answers	Marks
Lead carbonate (white lead) is very insoluble with high opacity and reflectance, all necessary properties for a good pigment. However lead is a cumulatively toxic heavy metal and prolonged exposure could, and did, cause lead poisoning and darkened skin.	2

Qu 27(c)

Suggested Answers		Marks
calcium	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$	4
chromium	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2\ 3d^4$	
With only 2 valence electrons calcium is restricted to the oxidation states 0 and +2. Chromium has 6 valence electrons in the closely spaced 4s and 3d sub-shells and shows a range of oxidation states from 0 to +6, the main ones being 0, +3 and +6.		

Qu 27(d)(i)

Suggested Answers	Marks
In a flame test the element is excited by heat to produce its emission spectrum. Sodium ions produce an intense yellow colour in a flame test, corresponding to the two closely spaced lines at 590 nm which make up its visible emission spectrum.	2

Qu 27(d)(ii)

Suggested Answers	Marks
The absorption spectrum would show the same two lines at 590 nm but as dark lines, with all other wavelengths being visible.	1

Qu 27(d)(iii)

Suggested Answers	Marks
Bohr built on the idea of the electrons being in orbits around the central nucleus but proposed that the electrons were restricted to orbits of definite and precise energy values. In its ground state the electrons of an atom occupy the lowest available energy levels. When atoms are excited electrons are raised to higher energy levels, from which they quickly return to the ground state. As they fall to lower levels the energy difference is given off as light. As the energies are precise, a line spectrum results, where the wavelength of each line depends upon the energy gap through which the electron falls.	4

Qu 27(e)(i)

Suggested Answers	Marks
The copper ion in solution is a complex ion with water molecules acting as ligands, with the formula $Cu(OH_2)_4^{2+}$ (formula or diagram, showing attachment of oxygen to copper).	2

Qu 27(e)(ii)

Suggested Answers	Marks
The colour changes from pale blue-green to intense blue-violet.	1

Qu 27(e)(iii)

Suggested Answers	Marks
The ammonia molecule has an unshared pair of valence electrons which are able to form a coordinate covalent bond with the copper ion.	1

Qu 27(e)(iv)

Suggested Answers	Marks
Complex ions of transition metals show strong colours which result from closely spaced energy levels in the valence shell of the metal ion, to which the ligands have contributed electron pairs. The nature of the ligand groups determines the precise spacing of these energy levels and hence the absorption spectrum of the complex ion.	2

Q28 Forensic Chemistry

Qu 28(a)(i)

Suggested Answers	Marks
Ca, Mn, Ti and another unknown element (or elements).	1

Qu 28(a)(ii)

Suggested Answers	Marks
Electrons exist in specific energy levels around the nucleus of an atom. When an atom is in the ground state, the electrons exist in the lowest possible energy levels. When excited, the electrons can be promoted to higher levels by absorbing energy. The electrons then emit specific wavelengths of light as they fall back to the lower levels. It is this emitted light that produces the spectral line in the emission spectrum. The energy levels in atoms are unique to that element and so the emitted wavelengths of light are unique for each element.	3

Qu 28(b)(i)

Suggested Answers	Marks
Carbohydrates are composed of carbon, hydrogen and oxygen with a general formula $C_x(H_2O)_y$. Glucose has a formula of $C_6H_{12}O_6$, [$C_6(H_2O)_6$] , and so fits this definition of a carbohydrate.	2

Qu 28(b)(ii)

Suggested Answers	Marks
Reducing sugars are easily oxidised by Benedict's solution due to the presence of a carbonyl group in their open chained structure. Non-reducing sugars do not have a carbonyl group in their open chained structure and so are not oxidised by Benedict's solution.	2

Qu 28(b)(iii)

Suggested Answers	Marks
Heat the test sample in air. An organic compound will burn to produce carbon dioxide, carbon monoxide or carbon or a combination of these. This test may produce gases that will be toxic when inhaled so it should be performed in a fume cupboard or a well-ventilated area. The use of heat requires that other combustible material must be kept clear. Protective clothing and gloves should be worm to avoid contact with the organic material and the gases produced as their effects may be unknown.	4

Qu 28(c)

Suggested Answers	Marks
DNA analysis allows the comparison of DNA from different samples to establish whether they came from the same person or from different people. Matching DNA samples is very accurate for identifying individuals as the chances of different people having a matching DNA profile is only one in many billion. Samples of body material left at a crime scene can be accurately matched to a guilty suspect using DNA analysis. This relies on the forensic analyst being able to obtain an uncontaminated sample from the crime scene. Since only very small samples are required (eg a drop of blood) this evidence is often readily available. It also relies on obtaining a sample from a possible suspect. This may not be possible for legal reasons or there may not be a suspect. The establishing of data banks of DNA material could assist in finding suspects. DNA analysis is a quite recent development and so may not have been available during initial investigations of 'cold case crimes". Provided samples were collected and stored correctly, DNA analysis can still be carried out so it can be extremely useful for providing new evidence to solve crimes. Accuracy is of vital importance in criminal investigations. Inaccurate results could result in an innocent person being convicted of a serious crime or a guilty person being acquitted. Inaccuracy could result from the evidence being contaminated at the crime scene, during collection or transport from the scene or at the forensic laboratory. Sloppy work practices during the analysis could also lead to inaccuracy. Such problems could not only affect the case being investigated but it could also bring into question the reliability and accuracy of the results of other investigations.	7

Qu 28(d)(i)

Suggested Answers	Marks
Amine group ($-NH_2$) and the carboxylic acid group (-COOH).	1

Qu 28(d) continues over page

Qu 28(d)(ii)

Suggested Answers	Marks
Gas chromatography requires that the sample be heated to produce a vapour. Many organic compounds including amino acids will decompose when heated and so will be difficult to identify. 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. If electrophoresis is performed at pH 3, aspartic acid (isoelectric point = 3) will be neutral and easily separated and identified against positively charged glycine and valine (isoelectric point =6). Glycine has a smaller molecular mass and so will move faster than the valine allowing them to be distinguished.	**5**