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 $\therefore$ 1000 kg = 10,000 moles	1
Moles of CO_2 needed = 10,000 moles $\therefore$ 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

20(c)

Criteria	Marks
1000 kg $CaCO_3$= 10,000 moles	1
$\therefore$ 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	1
$\therefore V = 1.8 \times 10^3$ mol X 24.79 L mol^{-1} = 4.46×10^4 L natural gas needed	

21(a)

Criteria	Marks
In the reaction magnesium atoms are oxidised to form magnesium ions, showing that it is an oxidation-reduction reaction.	1
Carbon atoms are reduced in the reaction (from +2 to 0).	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 $C_bV_b = 2 \times C_aV_a$ $25 \times 0.220 = 2 \times 18.7 \times C_a$ and $C_a = 0.147$ mol L^{-1}	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 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 x 24.31 = 1.251965 g	1
$\therefore$ Percentage of Mg by mass = 1.251965 x 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

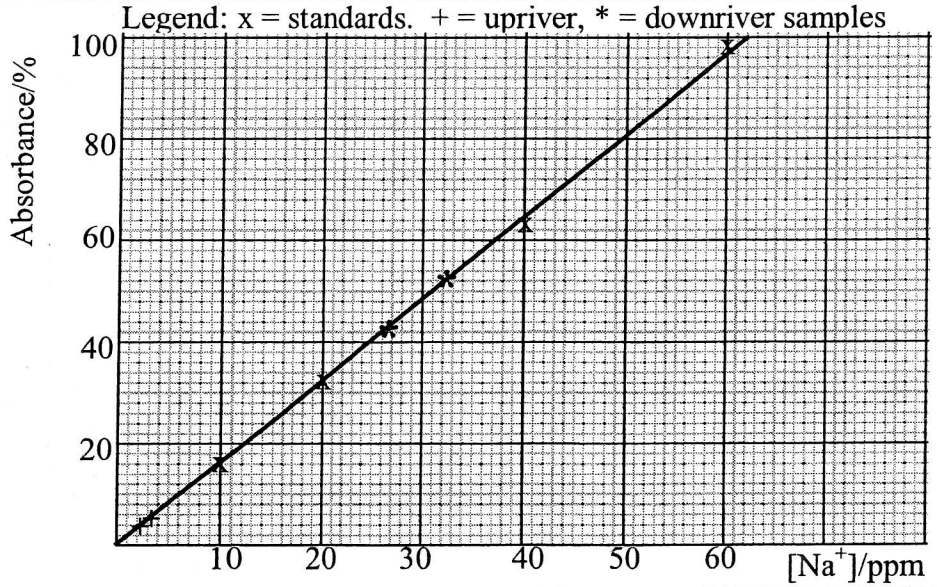
25(a), (b)

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 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

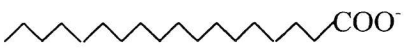
Q 27(c)(i)

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. 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 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

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.	

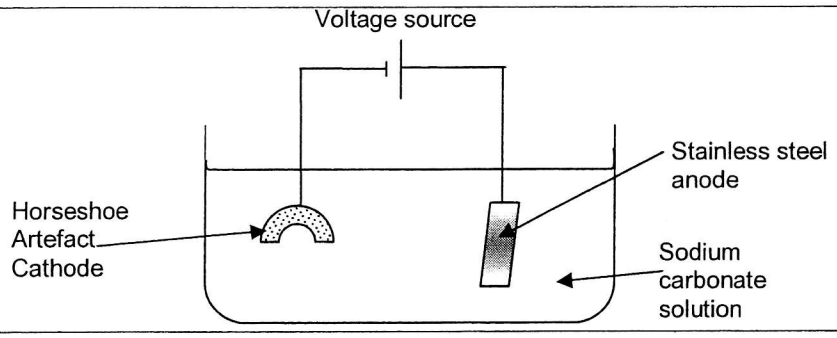
Q 28(b)(i)

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