Exam Choice

2006 Chemistry Trial HSC examination. Marking guidelines and sample answers.

Section I Part A Multiple Choice

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

Section I Part B

Question 16. (a)

Criteria	Marks
• Equation correct using molecular OR structural formulae. States not required.	1

$C_2H_4 + H_2O \rightarrow C_2H_5OH$

(b)

Criteria	Marks
• An outline of the procedure is given including details of sugar solution, catalyst and temperature.	2
• An outline of the procedure is given with incomplete details of conditions.	1

A spoonful of sugar can be dissolved in 100mL warm water in a conical flask. A spoonful of yeast can be added, a cotton wool stopper placed in the mouth of the flask which can be placed in an incubator at 30°C for 2 days.

(c)

Criteria	Marks
• Thorough explanation of one advantage and one disadvantage given. A thorough explanation would be indicated by equations, details of amounts or specifics.	3
• An outline of one advantage and one disadvantage without detail OR a detailed explanation of one advantage or one disadvantage.	2
• Some knowledge of the potential of ethanol as a replacement fuel, ie. it is a renewable fuel, it burns cleanly, it reduces our reliance on middle eastern countries, it may cause some damage to engines, it can only be used as a 10% blend with petrol.	1

Advantage: Ethanol burns more completely and cleanly than octane (petrol). Therefore it combusts producing carbon dioxide rather than the large amounts of toxic carbon monoxide and carcinogenic soot produced by the combustion of octane.
$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
$C_8H_{18} + 25/2O_2 \rightarrow 8CO_2 + 9H_2O$
The equations show how much more oxygen it takes to combust a mole of octane than ethanol.
Disadvantage: If ethanol were to be used on a wide scale, a large amount of sugary crop like corn or sugarcane would need to be grown. Ethanol is made by the fermentation of sugar from these. Wide scale land usage would be needed for these crops and this would either mean that current farms would need to be turned over to growing these crops or clearing native forests for additional land.

Question 17 (a)

Criteria	Marks
• A suitable risk assessment that includes an explanation of the risk, precautions that can be taken to reduce the risk and what to do in case of an accident.	2
• An incomplete risk assessment that explains a risk but does not explain how to reduce the risk OR does not explain what to do in the case of an accident.	1

Hair or loose clothing could catch on fire. To reduce this risk tie back hair and tuck in ties and other lose clothing. If hair or clothes do catch on fire, smother the flame with a fire blanket.

(b)

Criteria	Marks
• Correct heat of combustion calculated with working that shows how the answer was arrived at.	3
• One error in calculation but otherwise correct.	2
• One correct calculation made.	1

ΔH(ethanol) $= - mC\Delta T$
$= - 200g \times 4.18J \times 15°C$
$= - 12540J$ per 42.6 – 41.8g ethanol
$= - 12540J \times 46.0/0.8 \times 1/1000$
$= - 721kJ/mol$ ethanol

(c)

Criteria	Marks
• Correct explanation given in terms of bond formation.	1

As the alkanols get larger the molar heat of combustion gets larger because more carbon dioxide and water molecules are formed as products when they react. Heat is released when bonds are formed to make these products.

(d)

Criteria	Marks
• Any modification to the setup that would increase the accuracy of the result that is explained.	2
• Any modification to the setup that would increase the accuracy of the result that is described but not adequately explained.	1

The student could have placed a lid on the can of water. This would reduce the heat lost to the surrounding environment from the warm water. Heat loss to the environment is a significant error in this investigation.

Question 18 (a)

Criteria	Marks
• Correct metal identified.	1

The tin electrode.

(b)

Criteria	Marks
• Correct answer with some working.	1

$Sn \rightarrow Sn^{2+} + 2e^-$ $E^\circ = 0.14V$
$Ag^+ + e^- \rightarrow Ag$ $E^\circ = 0.8V$
$0.14 + 0.8 = 0.94V$

(c)

Criteria	Marks
• Detailed explanation of the function of a salt bridge involving the migration of ions to keep electrical neutrality OR an answer about allowing the completion of the circuit.	2
• An incomplete explanation but some knowledge of the function of a salt bridge OR identifying the porous pot as the salt bridge.	1

The porous pot allows ions to migrate from one half-cell to another. This keeps each half-cell electrically neutral. Galvanic cells cease to work when charge builds up around electrodes.

Question 19

Criteria	Marks
• Detailed explanation of the discovery of an element produced or discovered in past 50 years or since Neptunium's discovery in 1940. Explanation should include date, place and method.	3
• Outline of the discovery of an element produced or discovered in past 50 years or since Neptunium's discovery in 1940. Outline should include some details of date, place and method.	2
• One detail of the discovery of an element.	1

Element number 110 was first created in Darmstadt, Germany in 1994 by a nuclear reaction fusing lead and nickel ions in a heavy ion accelerator. Over a period of days, millions of nickel ions were accelerated into a lead target to produce a single recognizable atom of Darmstadtium.

$$^{208}_{82}Pb + ^{62}_{28}Ni \rightarrow ^{269}_{110}Ds + ^{1}_{0}n$$

This element was named Darmstadtium by the IUPAC in 2003.

Question 20 (a)

Criteria	Marks
• The name of any catalyst requiring reaction.	1

Esterification

(b)

Criteria	Marks
• The name of any catalyst that will catalyse the above reaction.	1

Concentrated sulfuric acid.

(c)

Criteria	Marks
• Detailed explanation of how catalyst operates.	2
• Outline of how catalyst operates. Ie..catalyst speeds up the reaction.	1

This reaction takes much energy for the reactants to reach their activation energy. The catalyst provides an alternative pathway for the reaction with a reduced activation energy. The reaction therefore proceeds at a faster rate.

Question 21 (a)

Criteria	Marks
• Correct equation with states.	1

$CuCO_3(s) \rightarrow CO_2(g) + CuO(s)$

(b)

Criteria	Marks
• Two straight, intersecting lines drawn through the points. Both axes labelled and with units. Time on the horizontal axis.	3
• Graph correctly drawn except for one or two errors ie.the plot is not a neat smooth curve through the points.	2
• Some elements of the graph are correct.	1

(c)

Criteria	Marks
• Correct answer to 2 significant figures with appropriate working.	2
• Correct answer but with too many or too few significant figures OR one error made in calculation.	1

$n(CO_2) = 0.092/24.79$
$= 0.00371$ mol
$n(CuCO_3) = n(CO_2) = 0.00371$
$m(CuCO_3) = 0.00371 \times 123.56$
$= 0.46g$

(d)

Criteria	Marks
• Assessment relates to less gas collected due to solubility of CO_2.	1

This procedure would lead to an under assessment of the copper carbonate present because CO_2 gas is soluble in water and therefore less gas will be measured than that originally produced.

Question 22

Criteria	Marks
• Thorough assessment of $NaHCO_3$ as a neutralising agent in spills. This should include at least 3 reasons why it is a good alternative with a clear assessment.	4
• Detailed assessment of $NaHCO_3$ as a neutralising agent in spills. This should include at least 2 reasons why it is a good alternative with a clear assessment.	3
• Sound assessment of $NaHCO_3$ as a neutralising agent in spills. This should include a well explained reason why it is a good alternative.	2
• One stated aspect of $NaHCO_3$ that would be relevant in its use as a neutralising agent.	1

$NaHCO_3$ has a number of advantages when used as a neutralizing agent in chemical spills. It is amphiprotic and will therefore neutralize both acid and base spills.
$HCO_3^- + H_3O^+ \rightarrow H_2CO_3 + H_2O$
$HCO_3^- + OH^- \rightarrow CO_3^{2-} + H_2O$
Because it is a weak base (or acid when neutralizing a base) any excess left after the spill has been neutralized will be harmless. It fizzes when it reacts so that it can easily be determined when the reaction is complete.
Because it is a solid, the remains can be swept up after the neutralization is complete and it does not leave a dangerous wet puddle.
Taking all these qualities into account it would appear that $NaHCO_3$ is a better neutralizing agent than most alternatives.

Question 23

Criteria	Marks
• Two special techniques described and explained in terms of their preciseness.	3
• Two techniques described but not adequately explained OR two techniques explained but not adequately described.	2
• One technique described or explained.	1

Technique 1: A 25mL pipette is used to transfer 25mL of the standard to a conical flask. A suction bulb is used to suck the standard up to the graduated mark on the pipette. The volume is then released into the flask. The tip of the pipette is touched to the side of the flask but the solution remaining is left in the pipette. A pipette is used in preference to a measuring cylinder because is measures 25mL more precisely.

Technique 2: All glassware used is rinsed before use. The burette is rinsed with the solution going into it to maintain its concentration. A few mL of the solution is placed in the top of the burette. It is swirled around and the tap is opened to release it and rinse through the whole of the burette. If it were rinsed with water the solution would become diluted.

Question 24

Criteria	Marks
• Detailed explanation of why it is crucial to maintain temperature and pressure close to optimum conditions. Explanation to include the result of temperature and pressure becoming too high and too low. Optimum conditions of temperature and pressure provided.	4
• Sound explanation of why it is crucial to maintain temperature and pressure close to optimum conditions. Explanation to include the result of temperature and pressure becoming too high or too low. Optimum conditions of temperature and pressure may not be provided.	3
• Limited explanation of why it is crucial to maintain temperature or pressure close to optimum conditions. Explanation to include the result of temperature or pressure becoming too high or too low. Optimum conditions of temperature and pressure not provided or inaccurate.	2
• Some knowledge of the effect of changing temperature or pressure on equilibria OR some knowledge of the need to monitor chemical reactions.	1

It is crucial to monitor the temperature because the production of ammonia from hydrogen and nitrogen is an exothermic equilibrium.
$3H_2(g) + N_2(g) \leftrightarrow 2NH_3(g)$ + heat
Enough heat needs to be supplied so that reactants reach their activation energy. However if too much heat is supplied the reverse reaction is favoured as it is endothermic and will help absorb the added heat. This will reduce the yield of ammonia. An optimum temperature of 400°C is maintained to gain the required yield of ammonia.
Pressure is monitored so that an optimum 250 atmospheres is maintained. If the pressure falls the reverse reaction will be favoured as the reverse reaction increases pressure and counteracts the loss of pressure. If pressure becomes too high the equipment becomes unsafe as it was not built to withstand pressures higher than 250 atmospheres.

Question 25

Criteria	Marks
• Thorough description and explanation of the need to monitor any named ion used by society. A thorough description would involve the source of the ion, how it moves into humans or other animals and a description of its harmful effects.	4
• Sound description and explanation of the need to monitor any named ion used by society. This description would involve the source of the ion and EITHER how it moves into humans or other animals OR a description of its harmful effects.	3
• A limited description or explanation of the need to monitor any named ion used by society. This would involve EITHER the source of the ion OR how it moves into humans or other animals OR a description of its harmful effects.	2
• Some knowledge of the need to monitor ions in society.	1

An ion such as lead needs monitoring in our environment for a number of reasons. Firstly, lead can escape from industry into waterways, from fuels such as petrol into the air and from the removal of lead based paints from renovation work into the air. Lead can then move into the food chain by being absorbed by fish across their gills into their blood supplies and stored in fat cells. Lead is a bioaccumulating chemical and remains in the fish body, accumulating throughout their life. It also passes up the food chain in increasing concentrations reaching dangerously high levels in animals at the top of the food chain such as tuna, swordfish, sharks and humans. In these animals and at these high concentrations it is toxic, causes brain damage and replaces calcium in bone. It can also be absorbed by humans by drinking water containing dissolved lead ions or by breathing air high in lead particles. In humans it can lead to retardation of intellectual development in children, anaemia or disruption to the reproductive system.

Question 26 (a)

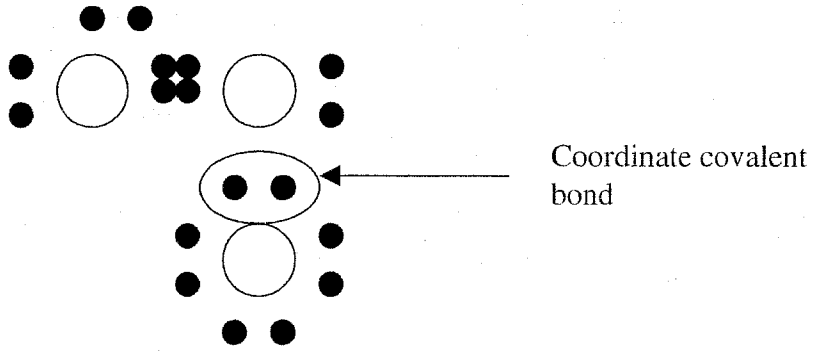
Criteria	Marks
• Correct definition.	1

This bond is a shared pair of electrons both originating from the same atom.

(b)

Criteria	Marks
• Correct Lewis diagram of ozone, hydronium or ammonium with correct location of coordinate covalent bond.	2
• Correct Lewis diagram of ozone, hydronium or ammonium without correct identification of coordinate covalent bond OR inaccurate diagram but correct location of coordinate covalent bond.	1

Coordinate covalent bond in ozone.



Question 27 (a)

Criteria	Marks
• Systematic name, common name or formula of either CCl_3F, CCl_2F_2 or CCl_2FCClF_2.	1

Trichlorofluoromethane.

(b)

Criteria	Marks
• Three equations correct. States not required.	2
• One correct equation to show one step in ozone destruction.	1

$CCl_3F + u.v.light \rightarrow Cl + \bullet CCl_2F$
$Cl + O_3 \rightarrow ClO + O_2$
$ClO + O \rightarrow O_2 + Cl$

(c)

Criteria	Marks
• HCFC's, HFC's and hydrocarbons given as replacements. Description of their effects on ozone compared to CFC's. A clear evaluation of their use given based on current measurements of ozone levels. The evaluation may be in terms of less u.v. radiation reaching troposphere and causing cancer.	3
• Some replacements given with a description of their effects on ozone compared to CFC's. No value judgement given or the evaluation too vague.	2
• One named replacement given OR no replacements given but some understanding of the value of replacing CFC's with other less destructive chemicals.	1

Most developed countries have met goals set by the Montreal Protocol to replace CFC's. Hydrochlorofluorocarbons were the initial molecules used to replace CFC's. These molecules are susceptible to decomposition by reacting with chemicals in the troposphere and only a small proportion reach the stratosphere where the ozone layer is. However they still cause some ozone destruction.
HFC's were used to replace these. Hydrofluorocarbons do not contain the destructive chlorine atom and so cause no damage to ozone. The most commonly used HFC is 1,1,1,2-tetrafluoroethane and it is widely used as a refrigerant in cooling units and air conditioners.
Hydrocarbons have been used to replace CFC's as the propellant in aerosol spray cans. These cause no damage to ozone.
The replacement of CFC's with HFC's and hydrocarbons have not yet led to a recovery of ozone in the stratosphere because there is so much CFC in the atmosphere and it takes years to decompose and drift out of the stratosphere. However the replacement has been valuable as the rate of ozone destruction has been shown to be slowing and scientists predict recovery in 50 to 100 years time.

Question 28 (a)

Criteria	Marks
• Some detail given on sanitation of local water. This should include more than the water is chlorinated.	2
• An understanding that chlorine in some form is used to sanitise water but no other detail given.	1

Sodium hypochlorite is added to the water supply to kill any microorganisms that might cause illness in humans. The hypochlorite ion is the active agent and enough is added that it remains effective all the way to the user but not too much that drinking water smells of chlorine. Sometimes ammonia is also added to extend the life of the chlorination process. It reacts to form the long living antibacterial chloramines.

(b)

Criteria	Marks
• A clear assessment given based on some evidence. The assessment may be positive or negative or both sides discussed.	2
• Discussion of effectiveness of chlorination but no clear assessment.	1

This method has proved to be highly effective as there is little evidence of people becoming ill or contracting dysentery by drinking the local water. The local water does not need to be boiled before drinking as in neighbouring countries and no special filters are needed other than those used to clarify the water.

Section II Options

Question 29 Industrial Chemistry

(a) (i)

Criteria	Marks
• Name of any non-fossil fuel natural product that is a shrinking resource.	1

Rubber

(ii)

Criteria	Marks
• Three issues discussed thoroughly.	3
• Two issues discussed in some detail.	2
• One issue identified.	1

Prior to 1940 rubber was obtained from plantations in Burma and Malaya. During WW2 the demand for rubber increased significantly because it was needed for tyres, however the supply dwindled as it was interrupted by the war. The traditional plantations could not meet the new demand and so an alternative product was needed.
Other issues associated with an increased need for a product such as rubber is cost. As the demand grows and supply dwindles the cost rises. The reliability of supply is also an issue, especially in this case where countries were reliant on rubber to have any chance of success in the war.

(iii)

Criteria	Marks
• Any replacement currently used or in production.	1

Styrene-butadiene rubber.

(b) (i)

Criteria	Marks
• Correct expression as in sample answer.	1

$K = [NO_2]^2/[N_2O_4]$

(ii)

Criteria	Marks
• Forward reaction identified as endothermic and explanation is complete.	2
• Forward reaction identified as endothermic with an incomplete explanation (but must provide some explanation)	1

As the brown colour becomes more intense, the concentration of brown NO_2 is increasing. Therefore the equilibrium is shifting to the right. As temperature was raised from 25°C to 35°C the equilibrium will shift to counteract the change and absorb heat. Therefore the shift right is endothermic.

(iii)

Criteria	Marks
• Correct answer backed up by sufficient working.	2
• Enough working to show that student knows how to calculate K values with some error made OR realization that the K value calculated is not equal to the value in the question.	1

	N_2O_4	$\Leftrightarrow$ $2NO_2$
Initial moles	***2 x 10^{-3}***	***0***
Δ	- 6 x 10^{-4}/2	+ 6 x 10^{-4}
Final moles	0.0017	***6 x 10^{-4}***
Final conc.	0.017 mol L^{-1}	6 x 10^{-3} mol L^{-1}

$Q = (6 \times 10^{-3})^2/0.017$
$= 0.0021$
$Q \neq K$. Therefore the system has not yet reached equilibrium.

(c) (i)

Criteria	Marks
• Correct reason relating to surface area.	1

It is sprayed into the burner because a high surface area of sulfur is needed to increase the collisions between sulfur atoms and oxygen gas molecules. As a liquid flowing through the burner the surface area of sulfur would be too low.

(ii)

Criteria	Marks
• Describing the conflict and resolution in depth without any missing steps. Details of catalyst and temperatures provided.	2
• Giving an outline of the conflict and resolution. This answer may not have details of catalyst and temperatures.	1

The conflict is that heat is required so that reactants reach their activation energy and the reaction proceeds at a high rate. However the forward reaction is exothermic. Therefore as temperature is raised the reverse reaction is favoured as it will counteract the change and absorb heat. This reduces the yield of SO_3 gas.
To resolve this conflict a vanadium oxide, V_2O_5, catalyst is used. This reduces the activation energy and the reaction will run at a lower temperature between 400°C and 500°C thus favouring the forward reaction and increasing the yield of SO_3. (in some cases a temperature up to 800°C is used.)

(iii)

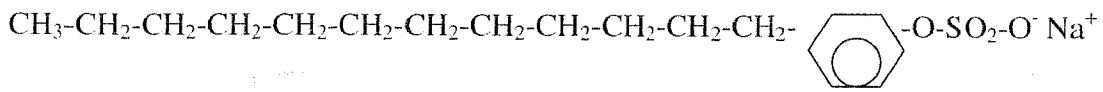
Criteria	Marks
• Any correct reaction equation where sulfuric acid is acting as an oxidising agent OR separate oxidation and reduction reaction equations. States not required.	1

Hot, concentrated sulfuric acid can be used to oxidize copper metal to copper(II) ions.
$Cu(s) + 2H_2SO_4(l) \rightarrow Cu^{2+}(aq) + SO_4^{2-}(aq) + SO_2(g) + 2H_2O(l)$

(d)

Criteria	Marks
• Thorough explanation of how the detergent molecule acts on grease. Description of anionic detergent molecule given and explanation includes how the micelles form.	3
• Sound explanation of how the detergent molecule acts on grease. Description of anionic detergent molecule included.	2
• Outline of some aspect of how an anionic detergent molecule works OR detail of its structure OR a good explanation of how another type of detergent or soap molecule works.	1

Sample Answer:
Anionic detergent molecules have a long, non-polar, hydrophobic carbon chain with a negatively charged, hydrophilic end.



The negatively charged end is attracted to polar water molecules and the long, non-polar chain forms dispersion forces with non-polar grease molecules. As the detergent is agitated, it lifts the grease from the plate.
The detergent molecules completely surround the grease molecules forming an emulsion. Small droplets called micelles are formed. The hydrophobic end of the detergent molecule bonds with the grease with the hydrophilic end pointing outward. Water molecules attach to these ends keeping the micelles separate.

(e)(i)

Criteria	Marks
• Correct half-equation with states.	1

$H_2O(l) + e^- \rightarrow 1/2H_2(g) + OH^-(aq)$

(ii)

Criteria	Marks
• Correct half-equation for production of O_2 or Cl_2 gases with states.	1

$H_2O(l) \rightarrow 1/2O_2(g) + 2H^+(aq) + 2e^-$

(iii)

Criteria	Marks
• Chlorine and sodium identified as new products with both half-equations.	2
• Either chlorine OR sodium identified as products with a correct half-equation OR both products identified without correct half-equations.	1

You would expect chlorine gas alone to form at the anode instead of both chlorine and oxygen gases.
$Cl^-(l) \rightarrow 1/2Cl_2(g) + e^-$
You would expect sodium to form at the cathode instead of hydrogen gas.
$Na^+(l) + e^- \rightarrow Na(s)$

(f)

Criteria	Marks
• A thorough discussion of two environmental issues with an explanation of how each are addressed.	4
• A sound discussion of two environmental issues with an explanation of how each are addressed.	3
• A thorough discussion of one environmental issue with an explanation of how it is addressed.	2
• Some knowledge of an environmental issue associated with the Solvay Process.	1

One significant waste product is $CaCl_2$. This can be used for a variety of purposes in other countries such as sprinkling on roads to de-ice them. However, in Australia there is little use for it. Therefore it needs to be disposed of. Solvay plants near the ocean discharge directly into the ocean following dilution. Any hydroxide that is also present is neutralized by HCO_3^-. Plants further from the ocean evaporate the salt to dryness then bury it. This can lead to salinity problems over time.
Thermal pollution is another potential environmental problem. Some reactions are exothermic and some waste heat is produced. Plants near the ocean discharge the hot water into the ocean. However this raises the temperature of the local environment and can lead to reduced oxygen levels killing organisms. To avoid this, most plants dilute the waste water until it is ambient temperature before releasing it.

Question 30 Shipwrecks, Corrosion and Conservation

(a)

Criteria	Marks
• Detailed explanation of Galvani's experiment and description of his later work.	3
• An explanation of Galvani's experiment and description of his later work but without detail.	2
• EITHER an explanation of Galvani's experiment OR brief description of his later work.	1

Volta demonstrated that it was the different metals in contact in an electrolyte solution that generated the electric current not the animal's muscle. He generated an electric current by sandwiching a piece of cardboard soaked in salt water between a piece of copper and a piece of tin.
He then produced *Volta's Pile*, a stack of such cells connected in series producing a large current. He therefore produced the first direct source of electric current which became widely used in Europe at the time.

(b)(i)

Criteria	Marks
• Correct equation with states.	1

$H_2O(l) + e^- \rightarrow 1/2H_2(g) + OH^-(aq)$

(ii)

Criteria	Marks
• Correct voltage	1

Voltage higher than 1.93V

(iii)

Criteria	Marks
• Any factor that could be used to measure the rate qualitatively or quantitatively for this reaction.	1

This investigator might have recorded the rate of bubbles being produced at the cathode on a 1 to 5 scale. 5 relating to vigorous bubbling and 1 for no bubbles. Vigorous bubbling would indicate a fast reaction rate and no bubbles would indicate a slow rate or no reaction.

(iv)

Criteria	Marks
• Any factor that could be varied and affect rate in this investigation with a correct result.	2
• Any factor that could be varied and affect rate in this investigation but with an incorrect result or too little detail.	1

Voltage. The higher the voltage the faster the reaction rate.

(c)

Criteria	Marks
• Detailed answer describing how rust forms and two different ways that cathodic protection can be achieved to prevent rust forming. Equations used to assist answer which is given in terms of oxidation and reduction.	4
• Sound answer describing two different ways that cathodic protection can be achieved to prevent rust forming but little detail on what causes rust. Equations used to assist answer which is given in terms of oxidation and reduction.	3
• An understanding of what cathodic protection is with one example outlined.	2
• Some knowledge of how to prevent oxidation of iron without detail.	1

Rusting occurs when iron is oxidised and water is reduced.

$$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$$
$$\tfrac{1}{2} O_2(g) + H_2O(l) + 2e^- \rightarrow 2OH^-(aq)$$

Rust forms when the products precipitate and dehydrate to produce Fe_2O_3.
Cathodic protection is a protection provided to metals where the metal object becomes the cathode rather than the anode. This works because the anode is usually oxidized and corrodes itself whereas reduction occurs at the cathode but it doesn't actually react itself. It is usually water and oxygen that are reduced at the cathode.

$$\tfrac{1}{2} O_2(g) + H_2O(l) + 2e^- \rightarrow 2OH^-(aq)$$

There are a number of ways that the metal can become cathodic. Sacrificial zinc anodes can be attached to the hull of a ship at periodic intervals. Zinc is more reactive than iron and will oxidize in preference.

$$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^- \qquad E^\circ = 0.76V$$
$$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^- \qquad E^\circ = 0.44V$$

The surrounding iron becomes cathodic.
Alternatively a small current could be applied to the iron surface pushing electrons into the iron and forcing it to become cathodic. This prevents oxidation occurring. Scrap metal is used as the anode. These anodes are placed on the outside of a ship and insulated from it.

(d) (i)

Criteria	Marks
• Any correct reason.	1

Acid accelerates corrosion but metals do not react with bases. Therefore by keeping the cannons in a basic solution, any chance of coming in contact with acid is removed.

(ii)

Criteria	Marks
• Any one correct procedure.	1

The coral may have been chiseled firstly to remove the majority, then the smaller deposits removed pneumatically with a dental drill. Finally the artifact may have been carefully soaked in a weak acid such as acetic acid to dissolve the remaining deposits.

(iii)

Criteria	Marks
• Thorough description and explanation given explaining both the cleaning of the surface and reversal of corrosion. Removal of chlorides also explained. Relevant equations given.	3
• Detailed description and explanation given explaining both the cleaning of the surface and reversal of corrosion.	2
• Some knowledge of reducing corrosion by electrolysis.	1

Corrosion would have been halted by electrolysis. The artifact would have been made to be the cathode and connected to a stainless steel anode. A low voltage applied over a long period would remove iron ions and reverse the corrosion by reducing ions back to the metal.

Cathode : $Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$

Anode : $2H_2O(l) \rightarrow O_2(g) + 4H^+ + 4e^-$

Electrolysis also serves to remove chlorides from the iron. If chlorides remain they can cause some destruction to the structure as it is dried and the salt crystals grow . They can also react with any moisture around and form hydrochloric acid which will accelerate corrosion. By making the artifact the cathode, the chloride ions migrate out of the artifact and toward the anode.

(iv)

Criteria	Marks
• Description and explanation given.	2
• Description of a correct method OR explanation of incorrect method.	1

The cannons may have been coated with wax. This is a non-polar substance and does not allow water to penetrate to the metal. It forms a physical barrier to oxidising agents. It dries clear and colourless so the cannons can be clearly observed in their original state.

(e)

Criteria	Marks
• Extensive answer that addresses at least 3 factors that affect corrosion rate. Each factor discussed in detail to explain its effect on corrosion rate. All relevant equations given.	6
• Detailed answer that addresses at least 3 factors that affect corrosion rate. Each factor discussed to explain its effect on corrosion rate. Some equations given.	5
• Detailed answer that addresses 2 factors that affect corrosion rate. Each factor discussed to explain its effect on corrosion rate.	4
• Sound answer that addresses 2 factors that affect corrosion rate. Each factor outlined to explain its effect on corrosion rate.	3
• Some factors that effect corrosion rate identified with little discussion of one.	2
• A factor that effects corrosion rate identified.	1

Oxygen levels, temperature, sulfate reducing bacteria and acidity all effect the rate of corrosion of steel shipwrecks in deep water.

Oxygen acts as an oxidant for corrosion of iron.

$$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$$

$$\tfrac{1}{2}\ O_2(g) + H_2O(l) + 2e^- \rightarrow 2OH^-(aq)$$

As oxygen enters the ocean from the surface and is used by marine organisms, levels are very low in the deep ocean. This would lead to a low rate of collisions between iron and oxygen and therefore a slow oxidation rate.

Likewise, the cold temperatures in the deep oceans would have the effect of reducing the rate of corrosion. This is because colder temperatures lower the rate of all chemical reactions as molecules have reduced kinetic energy and are less likely to react when they collide. However these two factors are compensated for by the presence of sulfate reducing bacteria. These bacteria are found everywhere in the ocean and gain their energy from reducing sulfate in the ocean.

$$SO_4^{2-}(aq) + 5H_2O(l) + 8e^- \rightarrow HS^-(aq) + 9OH^-(aq)$$

The electrons required come from the oxidation of available metal.

$$Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$$

Therefore they reproduce to huge numbers on shipwrecks as they are a large source of iron. These bacteria do not require oxygen as they are anaerobic organisms so the lack of oxygen in the deep oceans does not restrict them. The overall reaction for their activities is:

$$4Fe(s) + SO_4^{2-}(aq) + 5H_2O(l) \rightarrow 4Fe^{2+}(aq) + HS^-(aq) + 9OH^-(aq)$$

These bacteria result in the formation of rusticles on deep ocean wrecks as the ions precipitate as iron sulfide and iron hydroxide.

$$4Fe^{2+}(aq) + HS^-(aq) + 7OH^-(aq) \rightarrow FeS(s) + 3Fe(OH)_2(s) + H_2O(l)$$

Increased levels of acidity also accelerate corrosion as the reduction reaction involving water occurs more readily and with a higher reduction potential when H^+ is present. An acidic environment forms around deep wrecks as there is an abundance of organic matter present on wrecks. Bacteria survive by decomposing these when they die. The bacteria secrete acid. Some encrusting organisms also produce carbon dioxide when they respire. This dissolves in water forming carbonic acid.

Question 31 The Biochemistry of Movement

(a)(i)

Criteria	Marks
• all 3 correct	2
• one or two correct	1

A=peptide bond (covalent bond)

B=Hydrogen bond

C=disulfide bond

(ii)

Criteria	Marks
• Explanation complete including mention of active site and substrate.	2
• Incomplete explanation but some knowledge of effect of alteration of tertiary structure on active site.	1

The tertiary structure of an enzyme gives it an active site. This is the site where the reaction actually occurs. Bonds form between atoms in the active site and the substrate atoms. If the tertiary structure is altered the bonds are unable to form between the active site and the substrate.

(iii)

Criteria	Marks
• Both bond types are mentioned and strengths compared.	1

The energy supplied by water at 100°C is enough to break the hydrogen bonds that hold the tertiary structure together. However the primary structure is held together by covalent bonds. These are much stronger and boiling water does not supply enough energy to break these.

(b)(i)

Criteria	Marks
• Both features identified.	1

An amino acid has at least one primary amino group, ($-NH_2$) and at least one carboxyl group, (-COOH).

(ii)

Criteria	Marks
• Correct general formula given as structural or molecular formula.	1

The general formula is $NH_2CHRCOOH$ where "R" is a side chain.

(iii)

Criteria	Marks
• The chemistry of the peptide bond is explained and correct use of example given.	2
• The chemistry of the peptide bond is explained without correct use of example.	1

When amino acids link together the bond formed is called a peptide bond. It involves a condensation reaction between the anion COO^- at the end of one amino acid and the cation NH_3^+ at the beginning of another amino acid. A water molecule is eliminated at the junction. Using cysteine as an example, $NH_3^+CH(CH_2SH)COO^-$ reacts with $NH_3^+CH(CH_2SH)COO^-$ by eliminating an H_2O molecule forming $NH_3^+CH(CH_2SH)CO\text{-}NH\text{-}CH(CH_2SH)COO^-$.

(c) (i)

Criteria	Marks
• Production of pyruvate OR ATP production.	1

Glycolysis produces two molecules of pyruvate to be used in aerobic respiration and also anaerobically provides the cell with 2 ATP.

(ii)

Criteria	Marks
• States production of energy and gives use of this energy.	1

ATP provides energy to initiate the breakdown of glucose, but is also produced during glycolysis as energy is released.

(iii)

Criteria	Marks
• States NAD^+ as hydrogen acceptor from glucose.	1

NAD^+ accepts hydrogens produced during the oxidation of glucose in glycolysis. These hydrogens can be used to form lactic acid anaerobically from pyruvate.

(iv)

Criteria	Marks
• Two fates outlined with some detail of CO_2, H_2O and ATP production.	2
• Two fates outlined without details.	1

In muscle cells, pyruvate may be used anaerobically to produce lactic acid. Aerobically, pyruvate enters the TGA cycle where successive carbon atoms are removed as CO_2. Hydrogen atoms are passed along the cytochrome chain where water is produced. This process produces 38 ATP per glucose molecule oxidized.

(d)

Criteria	Marks
• Structure analysed in detail. Correct prediction of viscosity and solubility both well explained.	4
• Structure analysed. Correct prediction of viscosity and solubility both with sound explanation.	3
• Structure explained or drawn with some explanation of viscosity or solubility.	2
• Structure given in some form OR some understanding of viscosity OR solubility.	1

The glycerol molecule consists of a chain of 3 carbon atoms bonded covalently. Each has a hydroxyl (OH) group attached. The presence of 3 highly polar hydroxyls on such a small molecule makes this a highly polar molecule. The hydroxyls form hydrogen bonds with neighbouring glycerol molecules holding the molecules tightly together. This gives the substance a high viscosity. Glycerol does not flow to the extent that water does.
Each of the hydroxyl groups can also form hydrogen bonds with water. This accounts for its high solubility in water.

(e) (i)

Criteria	Marks
• Thorough answer comparing at least three different features of the two types of muscle cell. The different functions of the cells are described in detail.	4
• Sound answer comparing a few different features of the two types of muscle cell. The different functions of the cells are described.	3
• Some comparison of the two cell types with some indication as to their different functions.	2
• Some comparison of cells OR the function of at least one type of cell given.	1

There are two types of skeletal muscle cells, Type I and Type II. They are different in appearance, function and the type of fuel they use. Type I muscle cells are red in colour, they have many mitochondria and capillaries and few contractile filaments. On the other hand, Type II muscle cells are white in colour, they have few mitochondria and few capillaries but many contractile filaments. Type I fibres are slow twitch fibres that contract slowly whereas Type II fibres are fast twitch fibres that contract relatively quickly. Type I fibres carry out aerobic respiration and are used during normal day to day light exercise and endurance and distance running. Type II fibres carryout mainly anaerobic respiration. They are used during heavy exercise and fast running.

(ii)

Criteria	Marks
• Cause of muscle cell contraction identified as release of calcium ions and their action on actin and myosin fibres. Brief explanation of why ATP is consumed.	3
• Cause of muscle cell contraction identified as release of calcium ions but little understanding of its action on actin and myosin. Brief explanation of why ATP is consumed.	2
• Some understanding of the cause of muscle cell contraction OR why ATP is consumed.	1

Muscle fibres consist of contractile units called myofibrils which run the length of the fibre. Each myofibril is made up of units called sacromeres which themselves contain two proteins, myosin, a thick filament and actin, a thin filament. The actin fibres slide across the myosin by the action of cross-bridges that reach out from the myosin and attach themselves to the actin filaments. When the actin is pulled along the myosin, the sacromere shortens and the muscle contracts.
It takes a nerve impulse to trigger the release of acetyl choline from the end of the axon. This stimulates another electrical impulse which results in the endoplasmic reticula within the cell to release calcium ions over the actin and myosin. These ions allow contacts to be made which result in ATP being broken down and energy being released. It is this energy that allows the filaments to contract, shortening the muscle.

Question 32 The Chemistry of Art

(a) (i)

Criteria	Marks
• One mineral named that was used by these people.	1

Red ochre was used by aboriginal Australians thousands of years ago.

(ii)

Criteria	Marks
• Chemical composition given as name OR formula of compound.	1

Anhydrous iron(III)oxide, Fe_2O_3.

(iii)

Criteria	Marks
• A description of more than one problem caused by any potentially dangerous cosmetic used by ancient people. A clear assessment of the risk.	3
• A description of one problem caused by any potentially dangerous cosmetic used by ancient people.	2
• Name of any potentially dangerous cosmetic used by ancient people.	1

Early Egyptians used white lead as a base for face powder. Lead can be absorbed through the skin and accumulate in the body. It can potentially lead to neurological damage, effect reproductive systems, cause anaemia and can replace calcium in bones. Therefore lead was a dangerous chemical to use and has since been replaced by chemicals such as talc in modern times.

(b)(i)

Criteria	Marks
• Detailed explanation of the cause of the hydrogen spectrum.	2
• Limited explanation of the cause of the spectrum but some understanding displayed.	1

When hydrogen atoms are excited, electrons absorb energy and jump to higher energy levels. When the electron falls back to a lower level it emits energy of a certain wavelength which may be visible. An electron may fall from the 4th energy level to the 3rd or the 5th to the 2nd, etc. Each fall corresponds with a discrete coloured line. The series of lines is distinctive of each element and is called the line spectrum.

(ii)

Criteria	Marks
• Detailed description of how Bohr came up with his model based on hydrogen spectrum.	3
• Incomplete description of how Bohr came up with his model based on hydrogen spectrum.	2
• Some knowledge given on the nature of the Bohr model of the atom.	1

Bohr applied Planck's concept that energy is found in discrete bundles. He said that electrons move in a circular path around the nucleus but only at certain distances from the nucleus and do not radiate energy. Different energy levels exist around the nucleus and these correspond to the discrete spectral bands of the hydrogen spectrum. Each line in the spectrum represents a transition from one energy level down to another.

(iii)

Criteria	Marks
• Clear explanation of an accepted merit and a limitation of the Bohr model.	3
• Incomplete or unclear explanation of an accepted merit and a limitation of the Bohr model.	2
• Some knowledge of a merit OR a limitation of the Bohr model.	1

One merit of the model is that it accounts for the fact that atoms emit or absorb energy when electrons change energy levels. This explains the line spectrum observed when hydrogen atoms are energetically excited.
One limitation of the Bohr model is that while it successfully explained the hydrogen spectrum, it could not account for the lines observed in the atomic spectra of atoms containing more than one electron.

(c)

Criteria	Marks
• Complete outline explaining how infra-red spectroscopy can detect presence of a pigment.	3
• Brief outline explaining how infra-red spectroscopy can detect presence of a pigment.	2
• One relevant piece of information relating to the use of infra-red spectroscopy.	1

Molecules undergo stretching or bending vibrations which become excited by infra-red radiation. Each group of atoms making up a pigment has its own distinctive set of vibrational frequencies which can be measured by passing infra-red light through them and recording the wavelengths absorbed. The infra-red spectrum obtained can then be compared with a spectrum from a known pigment.

(d) (i)

Criteria	Marks
• Correct electron configuration.	1

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$

(ii)

Criteria	Marks
• Correct explanation of why iron is a transition metal.	1

Transition metals have an incomplete d-shell. Iron has a full 4s shell but only 6 electrons in the d-shell which can hold 10 electrons.

(iii)

Criteria	Marks
• Explanation in terms of ionisation energy to explain the oxidation states of Group I and transition elements.	2
• Explanation as to why Group I elements have an oxidation state of +1.	1

Group I elements lose one electron to achieve a stable full outer shell. It takes relatively little energy to remove this electron and therefore Group I elements have a low first ionization energy. It takes much more energy to remove the next electron because it must come from a shell much closer to the nucleus. Therefore Group I elements have a +1 charge when they react to form ions and therefore an oxidation state of +1 as this symbolizes the number of electrons lost on reacting. Transition elements may have 2 or three electrons in outer sub-shells which are close in energy. They may lose 2 electrons from a sub-shell and have an oxidation state of +2 or a 3rd electron from a close sub-shell and have an oxidation state of +3.

(e) (i)

Criteria	Marks
• Correct definition.	1

Molecules or ions attached to a metal ion in a complex ion.

(ii)

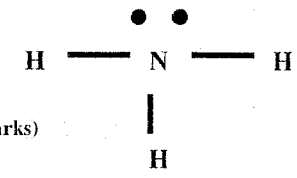
Criteria	Marks
• Correct name or formula of a chelated ligand.	1

Ethylenediamine

(iii)

Criteria	Marks
• Clear and well explained discussion of the value of models in understanding ligands using two examples. At least two advantages of models provided.	3
• Brief discussion of the value of models giving one advantage in understanding ligands. One example provided.	2
• Some knowledge of the value of model use in chemistry.	1

It would be difficult to understand the nature of ligands without the use of models. The diagram showing the shape and position of atoms is itself a model because it is a visual representation of a structure that we can't otherwise see. Trying to understand the nature of ethylenediamine from its molecular formula $C_2N_2H_8$ would not highlight the two positions on the ligand and where electron pairs can form bonds. The crab claw shape of the ligand can be clearly seen using a model. Even monodentate ligands can be better understood using models. NH_3 is a monodentate ligand who's bonding becomes easier to understand when modelled.



Question 33 Forensic Chemistry (25 marks)

(a) (i)

Criteria	Marks
• Two examples from two different classes.	1

Methylpropan-2-ol (tertiary alkanol) and propan-1-ol (primary alkanol)

(ii)

Criteria	Marks
• Any correct test that could be used to identify the two classes.	1

Primary alkanols will react with oxidising agents such as permanganate whereas tertiary alkanols will not react.

(b) (i)

Criteria	Marks
• Any two features that vary from place to place.	1

Particle size and colour.

(ii)

Criteria	Marks
• The use of soil explained with 2 features discussed in terms of how they vary.	2
• The use of soil explained *without* the 2 features discussed in enough detail.	1

Soil varies from place to place and features are distinctive of particular places. It can therefore be used to identify the location of a crime scene. Particle size varies from clay size to gravel sized particles. Colour varies from red to brown to black. Soil can be collected from under a shoe or in the fabric of clothing and analysed for these features.

(c)(i)

Criteria	Marks
• Correctly defines reducing and non-reducing sugars with example of each.	2
• EITHER correct definition OR correct examples.	1

Reducing sugars are those that are easily oxidized to alkanoic acids. Glucose is a reducing sugar.
Non-reducing sugars are not easily oxidized. Sucrose is a non-reducing sugar.

(ii)

Criteria	Marks
• Correctly outlines a test that would work giving positive and negative result and what can be concluded.	2
• Correct test identified without detail.	1

The sample can be dissolved in water then heated gently with a few drops of Benedict's solution. If a red-brown precipitate forms, the sugar is a reducing sugar. If the solution stays blue, the sugar is non-reducing.

(d)

Criteria	Marks
• Thorough answer that describes how both processes work. At least 2 similarities and 2 differences should be given. The properties of mixtures that facilitate the separation of amino acids outlined.	6
• Detailed answer that describes how both processes work. Some similarities and differences should be given. The properties of mixtures that facilitate the separation of amino acids outlined.	5
• Sound answer that outlines how both processes work. At least one similarity and one difference should be given. The properties of mixtures that facilitate the separation of amino acids outlined.	4
• Sound answer that outlines how both processes work. A similarity or difference given.	3
• An outline of either process given with little other detail.	2
• One thing given that relates to either process.	1

Both chromatography and electrophoresis are used to separate amino acids. Chromatography separates them on the basis of their different solubilities in polar and non-polar solvents. The solvent (called the mobile phase) is supplied at the top or bottom of absorbant paper (called the stationary phase) inside a sealed container. It washes the amino acids in the mixture being analysed at different rates up or down the paper due to their different polarities and therefore solubilities. The paper is then dried and sprayed with ninhydrin solution which turns the amino acids purple. The distance amino acids travel can be compared with a standard to identify them.
Electrophoresis separates amino acids based on differing charges and mobilities. Filter paper is soaked in an electrolyte with a buffer. Voltage is applied across the paper and the sample being analysed is placed on a line across the middle of the paper strip. Positively charged particles move toward the negative electrode and negative particles toward the positive electrode. Smaller particles move more rapidly than larger. The paper strip is sprayed with ninhydrin to make the amino acids visible.
Both methods can use paper as the substrate for the process but chromatography can also use liquid and electrophoresis a gel on a sheet of glass.
By changing the pH in electrophoresis, the charge on the amino acid will vary helping to separate the components of the mixture. In chromatography, varying the solution has the same effect although it is less effective than varying the pH in electrophoresis.
Electrophoresis requires more expensive equipment than chromatography although there is wide variety in cost depending on the type of chromatography and electrophoresis being compared.
Both methods are effective ways to separate amino acids and possibly assist in identifying them.

(e) (i)

Criteria	Marks
• All 3 parts correctly identified.	1

A = phosphate B = deoxyribose sugar C = base

(ii)

Criteria	Marks
• Correct description of DNA Data Bank.	1

The DNA Data Bank is a collection of DNA profiles available for law enforcement to use to help identify the perpetrators of crimes. These profiles come from convicted criminals in jails and not from the general population.

(iii)

Criteria	Marks
• A discussion of one ethical issue that covers both sides of the argument.	2
• A discussion of one ethical issue that only covers one side of the argument.	1

Civil libertarians are opposed to the collection of DNA profiles because they believe it is an invasion of privacy of individuals which may be innocent. Currently innocent suspects will volunteer their DNA to prove innocence. Civil libertarians believe that the onus is on the law to prove guilt not for innocent people to prove innocence. On the other hand, law enforcement agencies believe that it would save time and resources if innocent victims could be ruled out of the investigation.

(f)

Criteria	Marks
• Thorough outline of the workings of the mass spectrometer is given with an outline of its usefulness.	3
• Brief description of the workings of a mass spectrometer with outline of its usefulness.	2
• EITHER a brief description of the workings of a mass spectrometer OR an outline of its usefulness.	1

A gaseous sample is admitted to a vacuum chamber where it is bombarded by a beam of electrons. The electrons ionize the sample by knocking off electrons. These positive ions are accelerated through an electric field where they are separated according to their masses. The ions follow circular paths with the path of the smaller particles bending more than the large. The ions with their mass:charge ratios are detected electrically.
The mass spectrometer is useful to the forensic scientist as the spectra created are unique and enable molecules to be identified. For example trace amounts of drugs can be identified in body fluids.

(g) (i)

Criteria	Marks
• Answer in terms of energy levels or shells and electrons falling back and emitting light.	1

Electrons are excited to higher energy levels by the input of energy. When the electrons fall back to lower energy levels, energy is emitted in the form of distinct wavelengths of light.

(ii)

Criteria	Marks
• Correct name for instrument.	1

Spectroscope.

(iii)

Criteria	Marks
• Answer in terms of distinctive distances between energy levels or shells.	1

The distance between energy levels is different for every element.

Exam Choice

CHEMISTRY: HSC TRIAL 2006

Mapping Grid

Question No.	Marks	Syllabus Ref.	Outcomes (H-)	Target Performance Band(s)
PART A				
1	1	9.2.13	6	4
2	1	9.2.4	6	5
3	1	9.2.5	8	4
4	1	9.3.2	4	3
5	1	9.3.4	10	5
6	1	9.2.3	6	2
7	1	9.2.4	7	4
8	1	9.3.4	10	5
9	1	9.3.3	6	4
10	1	9.4.4	6	3
11	1	9.2.2	3	4
12	1	9.4.3	1	3
13	1	9.4.4	4	2
14	1	9.4.5	4	5
15	1	9.4.3	14	4
16	6	9.2.3	4,8,10	2-4
17	8	9.2.3	6,10,12	4-6
18	4	9.2.4	10,11	2-4
19	3	9.2.5	3	5
20	4	9.2.3	3	3-4
21	7	9.3.2	10	4-5
22	4	9.3.4	4,8	5
23	3	9.3.4	11	4
24	4	9.4.2	3,7	4-6
25	4	9.4.3	4	2-5
26	3	9.4.4	2	4
27	6	9.4.4	8,9	3-6
28	4	9.4.5	3,4	2-5

OPTIONS

29	a	5	9.5.1	4,5	2-5
	b	5	9.5.2	8,10	4-5
	c	4	9.5.3	8,10	3-5
	d	3	9.5.5	2,3	5
	e	4	9.5.4	6,7,8,10	4-6
	f	4	9.5.6	4	4
30	a	3	9.6.1	1,2,3	5
	b	5	9.6.3	6,7,8	3-5
	c	4	9.6.4	3,4,8	5
	d	7	9.6.7	3,8,11	2-5
	e	6	9.6.6	8	4
31	a	5	9.7.1	2,7,8	4-5
	b	4	9.7.4	2,9	3-5
	c	5	9.7.8	1,7,9	4-6
	d	4	9.7.3	6,9	4
	e	7	9.7.5	7,9	2-5
32	a	5	9.8.1	1,4	2-4
	b	8	9.8.2	2,14	4-5
	c	3	9.8.2	3,4	5
	d	4	9.8.3,9.8.4	2,6	3-5
	e	5	9.8.5	2,3	3-5
33	a	2	9.9.1	9,11,13	2-4
	b	3	9.9.1	1,3,4	2-4
	c	4	9.9.2	8,9,11,13	3-4
	d	6	9.9.3	3,9	4-6
	e	4	9.9.4	1,3,4	3-5
	f	3	9.9.5	3,4	4-6
	g	3	9.9.6	3,4	3-5