Chemistry
Trial HSC 2004

Name: _____

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board – approved calculators may be used
- Write your name at the top of all papers

Total marks - 100

Section I

75 marks
This section has two parts, Part A and Part B

Part A – 15 marks
- Attempt questions 1-15
- Allow about 30 minutes for this part

Part B – 60 marks
- Attempt all questions
- Allow about 1 hour and 45 minutes for this part

Section II - Options

25 marks

- Attempt ONE question from this section
- Allow about 45 minutes for this section

Section I (total marks 75)

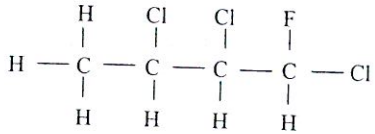
Part A (total marks 15)

Attempt Questions 1-15
Allow about 30 minutes for this part
Use the multiple choice sheet for your answers

1. Polyethylene is formed from monomers of ethene. Which of the following correctly describes the class of reactions it belongs to?

   (A) Reduction reaction
   (B) Oxidation reaction
   (C) Polymerisation
   (D) Condensation reaction

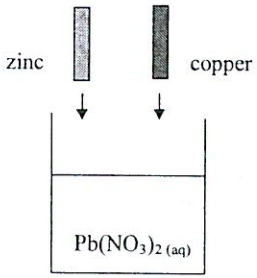
2. Name the following compound.



   (A) 1,2,3-trichloro-1-fluorobutane
   (B) 2,3,4-trichloro-4-fluorobutane
   (C) 3-trichloro-1-fluorobutane
   (D) 1-fluoro-1,2,3-trichlorobutane

3. The molar heat of combustion of 1-propanol is -2016 kJ.mol^{-1}. Which of the following statements is correct for 1-propanol when 5 g is combusted?

   (A) 168 x 10^3 kJ is released
   (B) 168 kJ is released
   (C) 32,000 J is absorbed
   (D) 24192 J is released

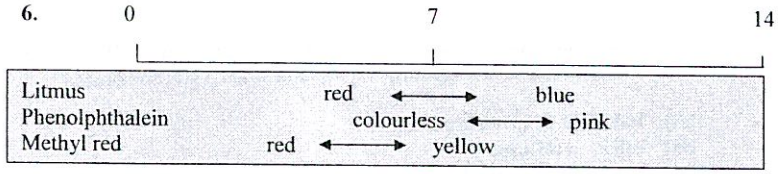
4. 

If clean samples of copper and zinc are dropped into a pure solution containing dissolved lead nitrate, which of the following best describes the reaction?

(A) The solution will turn blue because of copper ions
(B) The nitrate produces brown, poisonous NO_2
(C) The zinc becomes coated with copper
(D) The mass of the solid zinc will decrease

5. U-238 is an unstable isotope. What series of emissions could occur to produce U-234 as U-238 breaks down and radiates.

(A) Alpha, alpha, beta
(B) Beta, alpha, alpha
(C) Alpha, beta, beta
(D) Gamma, alpha, beta

6. 

10g of NaOH was dissolved in 100mL of pure water. Samples of the solution were then tested with the above indicators, which of the following best depicts the resulting colours?

	Litmus	Phenolphthalein	Methyl red
(A)	Red	Colourless	Most likely red
(B)	Blue	Pink	Yellow
(C)	Red	Pink	Yellow
(D)	Blue	Colourless	Yellow

7. An unknown substance was reacted with oxygen and then tested alternatively with wet blue and red litmus paper. The following are the results.

	Blue litmus	Red litmus
Element X	Blue	Red
X oxide	Red	Red

Which of the following groups of elements could have caused the above results?

(A) Carbon, nitrogen, sulfur
(B) Neon, helium, argon
(C) Magnesium, sodium, calcium
(D) Carbon, aluminium, zinc

8. $CaCO_3 + HNO_3 \longrightarrow$

In the above reaction, one of the products is a gas. If 61,975 mL of this gas forms, then calculate the mass of nitrogen needed for the reaction if the calcium carbonate is in excess. (Assume 100 kPa and 25°C)

(A) 35 g
(B) 70 g
(C) 28 g
(D) 56 g

9. A solution of sulfuric acid is made up by dissolving 5g of H_2SO_4 in 1000 mL of water. Compare the $[H^+]$ concentration of this solution to the $[H^+]$ concentration in $0.001 mol.L^{-1}$ of HCl.

(A) 50 times
(B) 500 times
(C) 10 times
(D) 100 times

10. A student wants to produce an ester and gathers the following substances and items for the reaction:

Reflux apparatus
Pentanoic acid
1-Butanol
Water bath
Glass ware

Which of the following correctly names the ester she will form and the essential item missing from the above list?

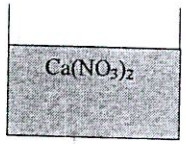
(A) Butyl pentanoate, concentrated hydrochloric acid
(B) Pentyl butanoate, concentrated sulfuric acid
(C) Butyl pentanoate, concentrated sulfuric acid
(D) 1-Butanyl pentanoate, gloves

11. $N_{2\,(g)} + 3H_{2\,(g)} \rightleftharpoons 2NH_{3\,(g)} \qquad \Delta H = -92\ kJ.mol^{-1}$

The above reaction is an essential process used in modern industries for the starting point to produce a large range of nitrogen based compounds from explosives to fertilisers. If this reaction was allowed to reach equilibrium, what would be the effect if more $NH_{3\,(g)}$ was to be injected into the reaction chamber?

(A) The temperature will decrease
(B) The concentration of hydrogen would decrease
(C) There would be no effect because it is on the product side
(D) The temperature will increase

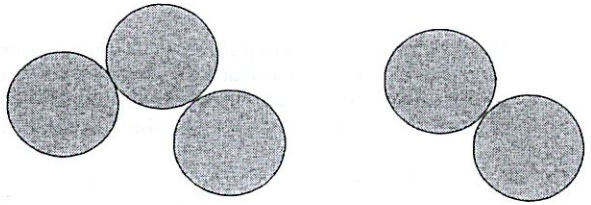
12.



You have been asked to confirm that an unlabelled beaker contains calcium nitrate by testing for the calcium ion. Which of the following results would confirm the presence of calcium?

(A) White precipitate with sodium sulfate and sodium fluoride solutions, and produces a brick-red flame colour
(B) White precipitate with lead sulfate and lead fluoride, and produces a brick-red flame colour
(C) Yellow precipitate with sodium sulfate solution and white with sodium fluoride solution, and produces a green flame colour
(D) White precipitate with sodium sulfate and potassium fluoride solutions, and produces a strong yellow flame colour

13.

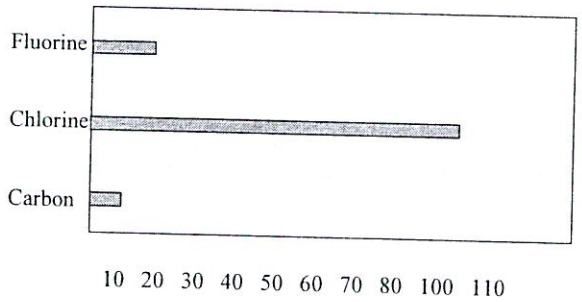


Ozone Oxygen molecule

The above are models of ozone and the oxygen molecule. Which of the following statements is correct in distinguishing between the properties of the two gases?

(A) Ozone contains more reactive oxygen atoms
(B) Ozone contains different isotopes to the oxygen molecule
(C) The oxygen molecule is more harmful to living things at the surface
(D) Ozone contains a coordinate covalent bond and the oxygen molecule does not

14. A chemical now banned in many countries was once used for making foam plastics and is now considered dangerous because of its ozone depletion qualities. The following table displays the relative masses of the elements present in one mole of the chemical.

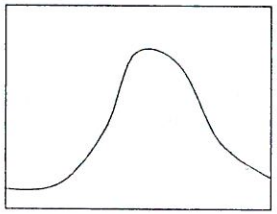


What is this chemical's name, assuming it only has one carbon per molecule?

(A) Dichlorodifluoromethane
(B) Trichlorofluoromethane
(C) Trifluorochloromethane
(D) Monocarbontrichlorofluoride

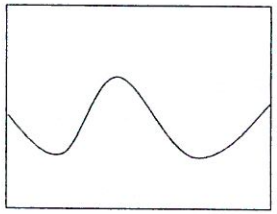
15. Heavy storms often occur up stream in our major waterways and days later the water surge passes through areas that have not seen any of the rain. Which of the following graphs would best depict the correct changes in the key freshwater indicators as one of these floods passes an observation site downstream of a storm?

(A) Turbidity



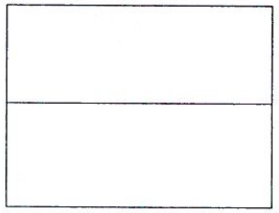
Before During After
Time of flood

(B) pH



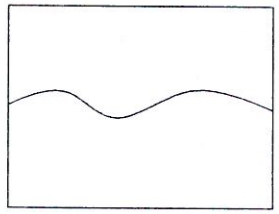
Before During After
Time of flood

(C) Total dissolved solids



Before During After
Time of flood

(D) Biochemical oxygen demand



Before During After
Time of flood

Section I (continued)

Part B (total marks 60)
Attempt Questions 16-25
Allow about 1 hour and 45 minutes for this part

Show all relevant working in questions involving calculations

Mark

Question 16 (6 marks)

(a) Write balanced equations for the following reactions. Name all reactants, products and special conditions.

(i) The reaction of ethylene (ethene) molecules to produce a polymer. 2

(ii) The reaction of ethanoic acid with potassium hydroxide. 2

(iii) The reaction of ethanoic acid with methanol. 2

Marks

Question 17 (6 marks)

(a) (i) Explain what is meant by "condensation polymer". 1

(ii) Outline the reaction involved in the formation of cellulose. 2

(b) Assess the potential of biopolymers as useful substances that can be used by mankind. 3

Marks

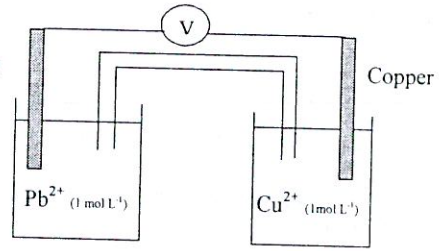
Question 18 (6 marks)

(a) "Zinc can be displaced from solution by lead but not magnesium".

(i) This statement appeared in a student's practical book after an experiment. Comment on it's correctness and restate it correctly if necessary. 1

(ii) Define the terms reduction and oxidation. Outline why the table of standard potentials has the reduction of water at –0.83 V and the oxidation of zinc at +0.76 V? 2

(b)



(i) Identify the anode in the above cell and state why you selected it. 1

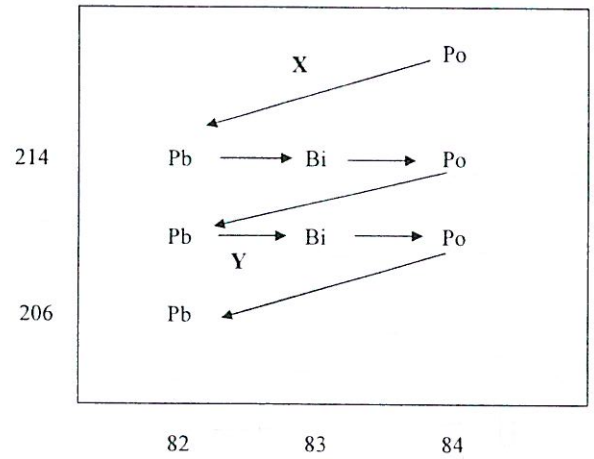
(ii) Write the net redox equation for the cell reaction and calculate the overall voltage (cell potential, E^0). 2

Marks

Question 19 (6 marks)

(a) (i) Under what conditions are atoms unstable? 1

(ii)



In the above radioactive sequence, describe the process and write equations for what is happening at X and Y. 2

Marl

(b) Name and describe a radioisotope used in each of the following: 3

(i) Industry

(ii) Medicine

Question 20 (6 marks)

(a) In a titration reaction, a student reacted 25 mL of 0.13 $mol.L^{-1}$ of hydrochloric acid against a barium hydroxide solution. His workbook showed the following results:

Titration	Reacting volume of barium hydroxide
A	16.4 mL
B	15.1 mL
C	15.2 mL
D	15.2 mL

(i) Write a chemical equation of this reaction 1

(ii) Determine the concentration of the barium hydroxide 2

Marks

(b) (i) Calculate the pH of a solution formed when 0.5g of sulfuric acid is dissolved in 1400mL of pure water. 2

(ii) To confirm this pH, comment on how useful the following table of indicators would be. 1

Indicator	Approximate pH range	Colour change
Litmus	4.7-8.3	red to blue
Phenolphthalein	8.2-10.0	colourless to pink
Bromothymol blue	6.0-7.6	yellow to blue
Methyl orange	3.2-4.4	red to yellow
Ethyl red	4.0-5.8	colourless to red

Marks

Question 21 (6 marks)

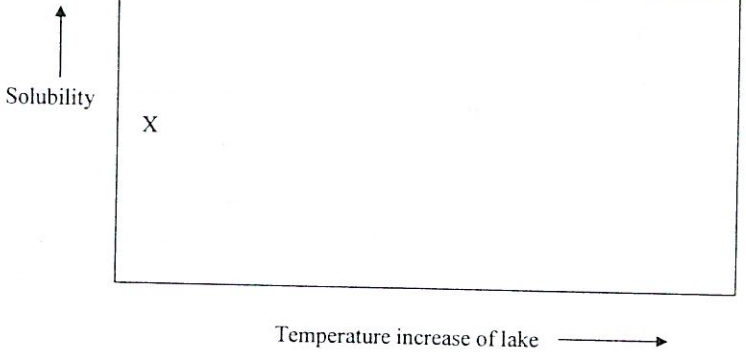
(a) The process of dissolving carbon dioxide in water is exothermic.

$$CO_{2(g)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)}$$

Use the above information to answer the following questions.

(i) Outline the main concept behind Le Chatelier's Principle. 1

(ii) 1



On the above graph draw a line roughly describing what happens to the solubility of carbon dioxide in a large lake as its temperature rises. Start from point X.

(iii) What part do the oceans play in balancing the overall carbon dioxide level in the atmosphere? 1

Marks

(b) (i) Compare the pH of 0.1 mol.L^{-1} HCl and 0.1 mol.L^{-1} H_2SO_4. State one reason for the difference. 2

(ii) Explain why the pH of 0.01 mol. L^{-1} HCl would be different to 0.01 mol.L^{-1} ethanoic acid (pH =3.4)? 1

Question 22 (6 marks)

(a) Outline the steps you carried out to complete a successful titration. Name the equipment needed for this process. 3

Marks

(b) (i) Outline the main reason that ethanoic acid has a slightly higher boiling point to that of ethanol. 1

	Boiling point ^0C
Ethanol	78.3
Ethanoic Acid	117.9

(ii) Describe why refluxing is a necessary part of the production of esterification. 2

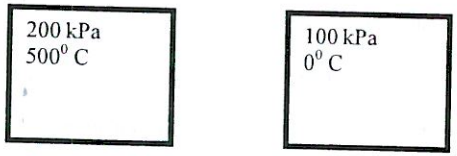
Question 23 (6 marks)

(a) (i) Write a balanced chemical equation for the complete combustion of 1-hexanol in the presence of excess oxygen. (Show all states of matter at 25^0C) 1

(ii) Describe how the reaction will vary if the amount of oxygen available is less than that needed for a complete combustion. 2

Marks

(b) The following two containers are identical in volume and sealed. Each had one mole of ammonia gas injected into them and the reactions were given time to set up equilibriums with their conditions. Compare the two reactions and their equilibrium concentrations taking into account that their conditions are different. (BP of ammonia is -33^0 C) 3



Container A

Container B

$2NH_{3(g)} \longrightarrow N_{2(g)} + 3H_{2(g)} \quad \Delta H = 92$ kJ/mol.

Question 24 (6 marks)

(a) Magnesium carbonate is one of the salts that makes water "hard".

(i) Outline a method to determine if a sample of water you have been given actually contains the carbonate ion. 1

Marks

(ii) If a 400 mL sample of this "hard" water was further tested and found to contain 20.2 mg of calcium carbonate, calculate the concentration in $mol.L^{-1}$. 2

(b) Describe the process used by atomic absorption spectroscopy (AAS) to identify metal ions in solution. 3

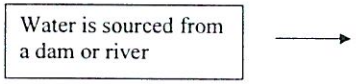
Question 25 (6 marks)

(a) (i) CFC-13 (1,1,2-trichloro-1,2,2-trifluoroethane) is one of the class of chemicals responsible for the depletion of the ozone layer in the last 50 years. Draw its structural formula. 1

(ii) Briefly describe the process that happens in the upper atmosphere involving CFC's that depletes the ozone layer. 2

Marks

(b) Draw a flow chart to summarise the processes used to clean and purify a town's water supply. 3



Section II: Options

Total marks 25

Attempt only ONE question from questions 26 – 30

Allow about 45 minutes for this section

Answer the question in the booklet supplied. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Question 26 **Industrial Chemistry**

Question 27 **Shipwrecks, Corrosion and Conservation**

Question 28 **Biochemistry of Movement**

Question 29 **Chemistry of Art**

Question 30 **Forensic Chemistry**

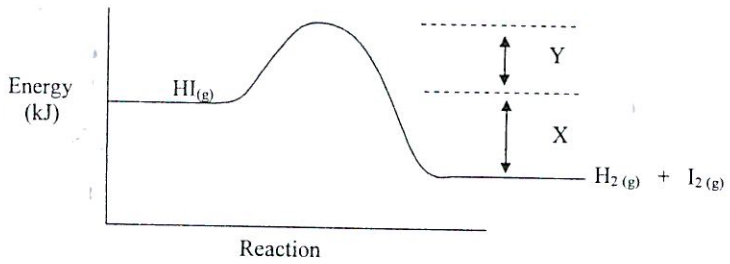
Marks

Question 26 **Industrial Chemistry** (25 marks)

(a) (i) Outline the major problems associated with the continued use of fossil fuels. 3

(ii) Choose one non-fossil based fuel and outline the positives and negatives associated with its future use. 2

(b) $HI_{(g)} \rightleftharpoons H_{2\,(g)} + I_{2\,(g)}$



The above reversible reaction can be described by this diagram.

(i) Explain what X and Y represent? 2

(ii) Draw a similar diagram to the one above to represent the reverse part of the reaction 1

(iii) Explain what effect an increase in temperature and a decrease in pressure would have on this reaction. Give reasons for your answers. 2

(iv) 3 mole of $HI_{(g)}$ is placed into a 2.0 L container and allowed to reach equilibrium producing an $H_{2\,(g)}$ concentration of 0.5 $mol.L^{-1}$. Calculate the equilibrium constant. 2

(c) (i) Describe an example of sulphuric acid acting as an oxidising agent and also as a dehydrating agent. 4

(ii) Compare the degree of ionisation of dilute and concentrated sulfuric acid. Explain your answer. 2

(d) (i) Briefly outline the membrane process for producing sodium hydroxide by electrolysis. 2

(ii) Name TWO advantages that the membrane process has over the older processes. 2

(e) (i) Describe a process that you carried out to produce soap (saponification) in the school laboratory. 2

(ii) Why are soaps often described as emulsifiers? 1

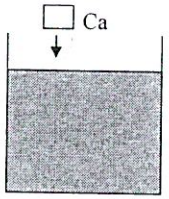
End of question 26

Marks

Question 27 **Shipwrecks, Corrosion and Conservation** (25 marks)

(a) Name two sources of minerals found dissolved in the ocean today. Outline how they were extracted from their source and transferred to the ocean. 2

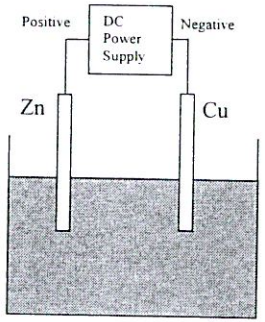
(b) 3



If a cube of calcium were to be dropped into a beaker of pure water, describe the reaction in terms of electron transfer. Write half and full equations in your answer and name the reductant.

(c) Describe a process that could be carried out in the school laboratory to analyse the conditions under which iron rusts. List and explain the expected results. 4

(d)



Copper sulfate solution

In the above electrolysis reaction the copper sulphate solution has a deep blue colour due to the concentration of the copper ions.

(i) Describe, with reasons, what will happen to the colour of the solution as the electrolysis proceeds. 2

(ii) Outline the factors that affect an electrolysis reaction. 3

(e) Compare the effectiveness of three different protections used to coat a metal such as iron and prevent corrosion. 5

(f) Briefly describe the conditions of temperature and pressure that will increase the solubility of oxygen. 2

Question 27 continues on the next page

Marks

(g) (i) What does the term "artefact" mean. Illustrate your answer with an example. 1

(ii) Copper or copper alloys were common materials used in early wooden boats. Describe one chemical procedure used to preserve or stabilise a copper based item found in an old ocean wreck. 3

End of question 27

Trial HSC Chemistry

2004

Answers

Section I: Part A

Multiple Choice Answers – Overlay Grid

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

Multiple Choice Answers – Descriptive Answers of Correct Choices

1. C Monomers (ethylene) react to form polymers (polyethylene).

2. A Start counting from the end with the most "non-hydrogen" elements and place in alphabetical order. Don't forget dashes and commas.

3. B Formula mass = 60 g/mol
   5 g represents 5/60 moles
   Therefore, heat released = 5/60 x 2016 kJ = 168 kJ

4. D As the solid zinc is above lead in the standard potential table (copper is below, so will not oxidise) its mass will reduce as it displaces lead from the solution.

5. C α emission produces Th-234
   β emission produces Pa-234
   β emission produces U-234

6. B The NaOH solution will be strongly alkaline. (pH = 12.4)

7. A They are all nonmetals, hence oxides are acidic in solution.

8. B $\frac{61.975L}{24.79} = 2.5$ moles of CO_2

   $CaCO_3 + 2HNO_3 \longrightarrow Ca(NO_3)_2 + CO_2 + H_2O$

   Therefore, moles of N = 5.0
   Mass = moles x molar mass
   = 5 x 14.01
   = 70 g

9. D For H_2SO_4:

   Moles of $H_2SO_4 = \frac{5}{100.07} = 0.05$

   Concentration $= \frac{0.05}{1} = 0.05$

   $[H^+] = 2 \times 0.05$
   $= 0.1$ moles/L

   For HCl:
   $[H^+] = 0.001$

   Therefore the ratio is $= \frac{0.1}{0.001} = 100$ times

10 C That is the correct name but it cannot be produced without the catalytic effect of concentrated H_2SO_4.

11. A The reaction moves in the endothermic direction (left) taking heat out of the surroundings. This decreases the temperature.

12. A These will identify calcium ions in the solution. Hint: lead sulfate and lead fluoride are insoluble and cannot form solutions to react.

13. D In ozone, the third atom is joined with the middle oxygen atom offering to supply <u>both</u> electrons for the bond (coordinate covalent bond)

14. B CCl_3F : In one mole of the substance,
C = 12
Cl x 3 = 106
F x 1 = 19
This is the same ratio as the graph in terms of mass.

15. A The increase in turbidity (cloudiness from the mud taken by the flood) is the only one that makes sense.

Section I: Part B Answers

Question 16

(a) (i) $n CH_2CH_{2\,(g)} \longrightarrow -(CH_2CH_2)_n-$
ethylene → polyethylene
Low density: needs peroxide initiator, 100-300 atmospheres and approximately 300°C
High density: needs metal catalyst, only a few atmospheres and approximately 60°C

(ii) $CH_3COOH + KOH \longrightarrow CH_3COOK + H_2O$
ethanoic acid + potassium hydroxide → potassium ethanoate + water
This is an acid/base reaction and only needs a water based solvent to react in.

(iii) $CH_3COOH + CH_3OH \longrightarrow CH_3COOCH_3 + H_2O$
ethanoic acid + methanol → methyl ethanoate + water
Needs: refluxing, heat and concentrated H_2SO_4 catalyst.

Question 17

(a) (i) As some polymers form, one of the products released is water due to the removal of oxygen and hydrogen from the monomer molecule. This forms a wet condensation over the fresh plastic.

(ii) Cellulose is a condensation reaction between glucose molecules.

$n\, C_6H_{12}O_6 \longrightarrow -(C_6H_{10}O_5)_n- + H_2O$

(b) Points to note:
1. Define what a biopolymer is (ie polymers made from living things)
2. Give some examples of biopolymers, eg cellulose variations like celluloid, rayon, carboxymethyl cellulose, cotton, wool.
3. Comparisons could be made to petroleum products in terms of biodegradability etc.
4. Further comments could involve cost, ease of production, flammability of cellulose based products, and the effect on the environment.

Question 18

(a) (i) The statement is incorrect. In a natural reaction (ie. not electrolysis) then the correct statement would be:
"Zinc can displace lead from solution and magnesium can displace both"

(ii) Reduction is the taking of electrons during a reaction. Oxidation is the releasing of electrons during a reaction.
The voltages stated are relative to the O/R of hydrogen set as a standard at $E^o = 0$. The sign depends on the direction taken in the reaction. All solutions are standardized at 1.0 mol./L.

(b) (i) Anode is where oxidation is occurring ie. copper electrode

(ii)
$Cu^{2+} + 2e \longrightarrow Cu_{(s)}$ 0.34
$Pb(s) \longrightarrow Pb^{2+} + 2e$ 0.14
Overall: $Pb(s) + Cu^{2+} \longrightarrow Cu_{(s)} + Pb^{2+}$ 0.48

Question 19

(a) (i) 1. If there are too few or too many neutrons in the nucleus
2. If they have an atomic number above Pb in the periodic table.

(ii) X is an alpha decay to remove extra mass

$$^{218}_{84}Po \longrightarrow ^{214}_{82}Pb + ^{4}_{2}He$$

Y is beta decay to reduce the number of neutrons. A neutron changes into a proton emitting an electron

$$^{210}_{82}Pb \longrightarrow ^{210}_{83}Bi + ^{-1}_{0}e$$

(b) Points to note:
The radioisotope needs to be named and described in detail. Safety issues could be mentioned

Question 20

(a) (i) $2HCl + Ba(OH)_2 \longrightarrow BaCl_2 + H_2O$

(ii) $aC_AV_A = bC_BV_B$
$2 \times 0.13 \times 25 = 1 \times C_B \times 15.13$

$C_B = 0.43$ mol/L

$V_B = (15.1 + 15.1 + 15.2)/3$
$= 15.13$ mL
(16.4mL was discarded as inaccurate)

(b) (i) Moles in 0.5 g of $H_2SO_4 = \frac{0.5}{98} = 0.0051$

$\text{Molarity} = \frac{0.0051}{1.4} = 3.64 \times 10^{-3}$ mol/L

$[H^+] = 2 \times 3.64 \times 10^{-3} = 7.3 \times 10^{-3}$ mol/L

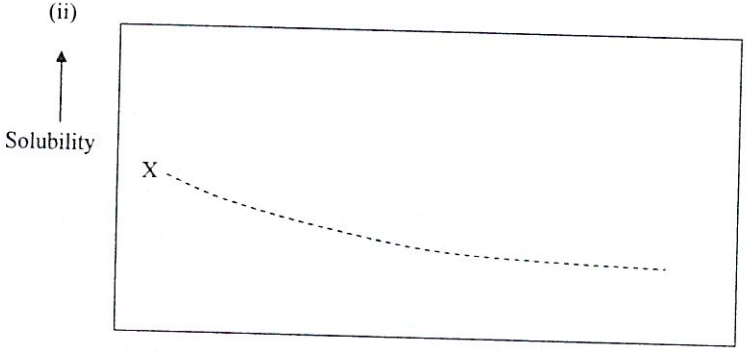
pH = 2.1

(ii) To be most effective a pair of indicators selected with colour changes either side of the above pH would be best. In this case they all change above the 2.1, so the most acceptable compromise would be to use the lowest ie. methyl orange, where a colourless solution should occur when added.

Question 21

(a) (i) When a system at equilibrium is disturbed, then the system adjusts itself so as to minimise the change.

(ii)



(iii) The oceans in the colder regions (poles) of the planet absorb a lot of the excess CO_2 put into the atmosphere as per Le Chatelier's principle. Unfortunately, the oceans are warming and this is causing increases in CO_2 concentration in the atmosphere both due to reduced absorption and also possible release from the warmer water. Higher atmospheric CO_2 is gradually multiplying the effect because of global warming (greenhouse effect).

(b) (i) 0.1 mol/L HCl: pH = 1
0.1 mol/L H_2SO_4 : pH = 0.7 (stronger acid)
The reason is H_2SO_4 releases two H^+ per formula to one from HCl.

(ii) HCl is fully ionised and hence a strong acid and ethanoic acid is only weakly ionised, so does not release all the H^+. This makes it a weak acid.

Question 22

(a) Points that should be noted :
The use of the correct equipment (pipettes, burettes, flasks)
Correct washing techniques
Use of standard solutions
Correct indicator choice
Trial run then two titrations
Methods in place to maintain accuracy

(b) (i) Ethanoic acid has two oxygen atoms base on the same end of the molecule while ethanol only has one. This means that the "hydrogen bonding" between molecules of ethanoic acid is stronger and more energy is needed to separate them. Hence a higher BP.

(ii) Alkanoic acids and alkanols combine to form esters. This is a slow reaction needing heat and an acid catalyst. This means that the two volatile (highly evaporative) chemicals need to be kept in contact for lengthy periods of time to maximise the chance of a successful collision. Reluxing does this by supplying a cooling tower for recycling the reactants back down into the flask.

Question 23

(a) (i) $C_6H_{14}O_{(l)} + 9O_{2(g)} \longrightarrow 6CO_{2(g)} + 7H_2O_{(l)}$

(ii) As the amount of oxygen is restricted then intermediate products will form like carbon (smoke and soot) and CO along with the normal products, CO_2 and H_2O. The first two can be burnt further with excess oxygen. This is how carbon based combustion normally occurs in nature, like in bushfires.

(b) Points to note when comparing:
1. Both are endothermic to the right.
2. Container A, when compared to B, has a higher pressure and this should move the reaction to the left. But this is overwhelmed by the higher temperature moving the reaction to the right. A balance will eventually be achieved.
3. The higher temperature in container A produces a higher reaction rate compared to B.
4. Overall, there should be higher concentrations of N_2 and H_2 in container A compared to B.
5. Both A and B should only contain gases.
6. Container A should reach equilibrium faster due to a higher temperature increasing the reaction rate.

Question 24

(a) (i) Add a dilute acid like HCl or HNO_3 to the water sample after it has been heated to 70-80°C and test the evolving gas with limewater (if possible). The limewater will show the gas is CO_2. This will not work with very low concentrations because the CO_2 dissolves in the water. Also, if the pH is less than 6.5, then it is unlikely to have significant amounts of carbonate.

(ii) $20.2\text{ mg} = 2.02 \times 10^{-2}\text{ g}$

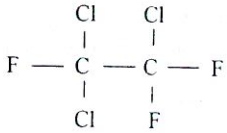
$$\text{moles} = \frac{mass}{mm} = \frac{2.02 \times 10^{-2}}{84.31} = 2.39 \times 10^{-4} \text{ moles in 400 mL}$$

$$\text{Therefore concentration} = \frac{2.39 \times 10^{-4}}{0.4} = 6.0 \times 10^{-4} \text{ mol/L}$$

(b) The basic points needed include:
1. The machine is standardized to the current conditions.
2. Vapour containing traces of the metal are sprayed into a flame.
3. Atoms of the sample being analysed absorb some of the light from the source in specific wavelengths (quanta) which is a signature for each element.
4. The changed light is then filtered by a monochromator and electronically analysed.
5. The amount of absorbed light and "lines" are a very accurate indication of especially small concentrations.

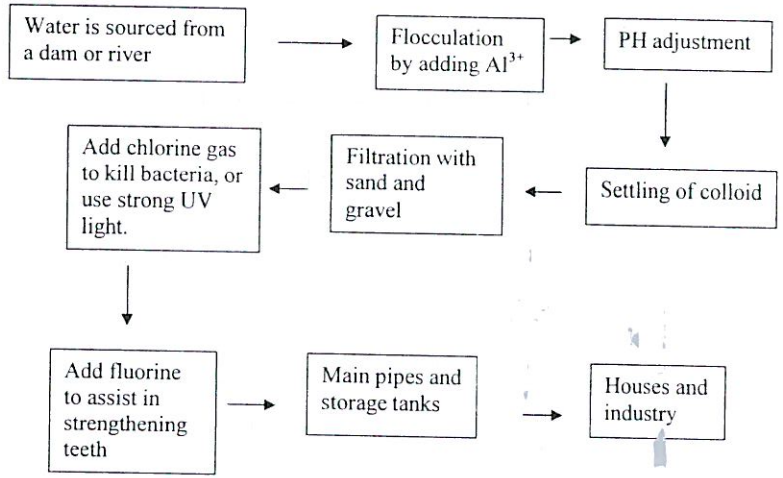
Question 25

(a) (i)



(ii) Briefly:
1. CFC releases a Cl atom because of UV bombardment.
2. The Cl atom reacts with $O_{3(g)}$ and goes through a series of reactions to convert $O_{3(g)}$ and $O_{(g)}$ to $O_{2(g)}$, hence stopping any further $O_{3(g)}$ from forming.
3. At the end of the reactions, the Cl is freed to continue doing damage.

(b)



Section II: Options

Question 26

(a) (i) Points that could be outlined:

1. Increasing cost of fossil fuels
2. Shrinking supply over the next few decades
3. Pollution effects on crowded cities
4. Effect on global warming from the release of oxides of combustion
5. Leaded fuel is still being used
6. The effect of jet engine emissions on the upper atmosphere
7. Should be conserved for the long term and more valuable uses such as construction material, plastics, medicines etc.
8. A lot of the oil is derived from politically unstable areas.

(ii) Some examples areas that could be discussed:

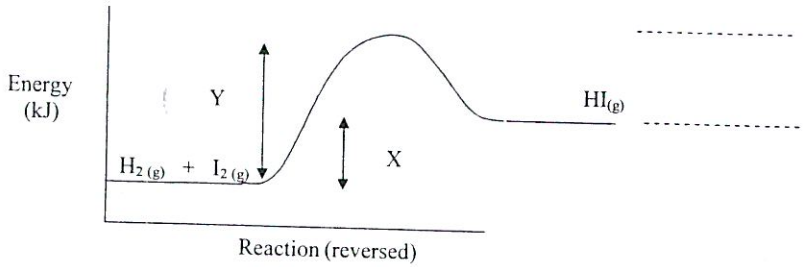
1. Deriving ethanol from sugar
2. The current move towards hydrogen as a fuel
3. The use of biomass fuels

Most problems centre around supply costs and degradation of the environment due to farming practices. Also, most methods still produce CO_2 in the process.

Most positives may include reduced reliance on non-renewable fossil fuels and possible increase in jobs as in the sugar can industry in Australia. Hydrogen is a special case that combusts to water and has a high energy output. Storage and supply may be a challenge.

(b) (i) X is the exothermic energy given out as the reaction proceeds in the forward direction. It is absorbed in the reverse direction.
Y represents the activation energy needed for the bonds to be broken and the reaction start in the forward reaction.

(ii)



(iii) First the equation needs to be balanced.

1. An increase in temperature will move the reaction towards the $HI_{(g)}$. This is the endothermic direction and also speeds up the reaction.
2. Decrease in pressure has no effect due to equal numbers of molecules on both sides.

(iv) $2HI \rightleftharpoons H_2 + I_2$ conc. = 3/2.0 = 1.5 mol/L

Before:	1.5	0	0
After:	1.5-1.0 = 0.5	+0.5	+0.5

$$K = \frac{[I_2][H_2]}{[HI]^2} = 1$$

(c) (i) Oxidising agent: React hot concentrated H_2SO_4 with solid copper. The copper is oxidised and the sulfur reduced.

Dehydrating agent: Ethanol has the equivalent of a water molecule removed by concentrated H_2SO_4 during the formation of ethene. Sucrose is dehydrated to carbon by concentrated H_2SO_4 also.

(ii) Concentrated H_2SO_4 tends to have very few H_2O molecules present to cause ionisation, so it tends to be partially ionised. Dilute H_2SO_4 has plenty of water so is fully ionised, hence it is a strong acid.

(d) (i) Basically, a membrane allows only Na^+ ions to pass through from the anode solution to the cathode solution. $Cl_{2\,(g)}$ is removed at the anode, $H_{2\,(g)}$ is removed at the cathode and finally the NaOH solution is removed from the cathode side to be further purified.

(ii) Possible points:

1. It is less complex
2. There are no pollutants like Hg or asbestos involved.
3. A very pure NaOH solution is produced.

(e) (i) The following is one method:

1. To 15 mL of vegetable oil add 40 mL of concentrated NaOH solution.
2. Heat the mixture with care and stir until the oil disappears.
3. Allow to cool and "salt out" with 60 mL of concentrated NaCl solution.
4. Filter carefully or collect after the soap has floated to the top of the solution.
5. Safety: Use boiling chips, safety glasses and very carefully handle the concentrated NaOH.

(ii) Soap molecules surround oil and dirt by "dissolving" one end of their molecules in the oil. After agitation, the soap holds the oil in small droplets producing a cloudy emulsion.

Question 27

(a) Two major sources include:

1. Land (terrestrial) rocks. The action of weathering leaches minerals from the rocks and soils. Erosion transports the minor amounts of dissolved salts via surface water (streams etc.) and subsurface water (groundwater, aquifers) to the oceans. Over hundreds of millions of years the oceans have gradually became more salty.
2. Volcanic and hydrothermal action. Hot water leaches subsurface rocks quickly and injects higher concentrations of salts into the ocean than comes from the land.

(b) $Ca_{(s)} \longrightarrow Ca^{2+} + 2e^-$

$2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-$

$Ca_{(s)} + 2H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)} + H_{2(g)}$

Two electrons are released per atom of calcium (the reductant) and transferred to water where the two hydrogen atoms pick up an electron each to form $H_{2(g)}$.

(c) An example is to use a set of identical iron nails and place them in a variety of conditions such as:

1. In tap water (some rusting expected, poor electrolyte)
2. In salty water (greater rusting expected due to electrolyte and dissolved oxygen)
3. In a dry, sealed test tube (virtually zero rusting expected because of a lack of electrolyte)
4. In oil (zero rusting due to a lack of an electrolyte)
5. Wrap in copper in a salty solution (accelerated rusting due to the availability of oxygen , an electrolyte and the sacrificial anode role of the iron when placed next to the copper)
6. Wrap in zinc in a salty solution (virtually no rusting due to sacrificial nature of the zinc when in contact with the iron)

Overall, for the rusting to occur there needs to be oxygen and an electrolyte present. This can be accelerated or retarded using sacrificial anodes.

(d) (i) Copper ions from the solution will reduce onto the copper electrode to supply electrons there. As the Cu^{2+} concentration drops so does the blue colour. Zn enters the solution as an ion but unlike the copper ion, it is colourless.

(ii) Electrolysis can be affected by:

1. The voltage of the power supply. The higher the voltage (to a limit) the higher the reaction rate.
2. The reaction rate is affected by the concentrations of the solutions. The higher the concentration, the higher the rate.
3. The type of electrolyte. It has to be compatible with the reaction.
4. Also the electrodes need to be appropriate for the electrolysis.

(e) Ideally the comparison should involve at least three type of protection.
Passive protection

1. Coating with oils and greases, especially good for long term storage.
2. Paint prevents air and water from contacting the surface. This is good if there is no mechanical wear and tear.
3. Enameling. This is very strong and resilient, often used in cooking utensils and high wear areas.

Active protection

1. Coating with a metal higher in the O/R table. For instances, a zinc coating will "sacrifice" itself by oxidising before the iron and turning the iron into a cathode. Hence stopping oxidation.

Comparisons could include the following in the discussion:

1. Cost of each method
2. Strength and appropriateness for the task the metal is being used for.
3. Chemical or active protection versus passive protection

(f) The ideal conditions to maximise O_2 solubility would be high pressure and low temperature.

(g) (i) Artefact (or artifact) is a term to describe a man made item or group of items from the past. Usually used to describe the remains of wrecks, old villages etc. An example would be a vase, coin, wood from a sunken boat.

(ii) There is a wide range of chemical techniques. Any one of the following would suffice.

1. Removal of carbonates using organic acids.
2. The leaching of chlorides by emersion in Na_2CO_3
3. Removal of chloride by electrolysis.