
Student Number

Sydney Girls High School

2006

HSC TRIAL EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Board-approved calculators may be used
- A data sheet and Periodic Table are provided at the back of this paper.
- Draw diagrams using pencil

Total marks – 100

Section I Pages 3–16

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 questions 16–26
- Allow about 1 hour and 45 minutes for this part

Section II Page 17

25 marks

- Attempt question 27
- Allow about 45 minutes for this section

Section I
75 marks

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

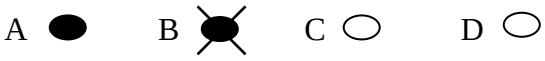
Use the multiple-choice answer sheet.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

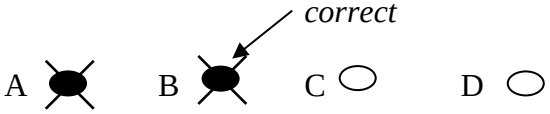
Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.



If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

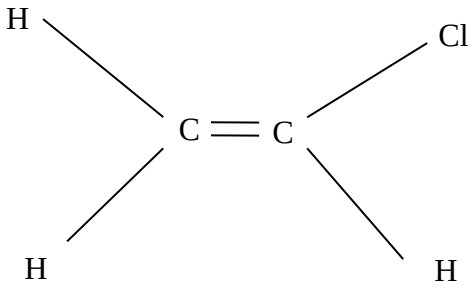


1 Which of the following substances can be cracked as the industrial source of ethylene?

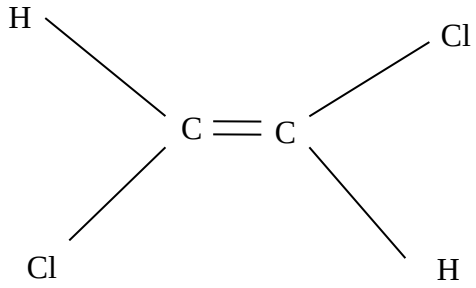
(A) Cellulose
(B) Alkanols
(C) Carbohydrates
(D) Alkanes

2 Select the correct structure of the monomer used to prepare poly(vinyl chloride).

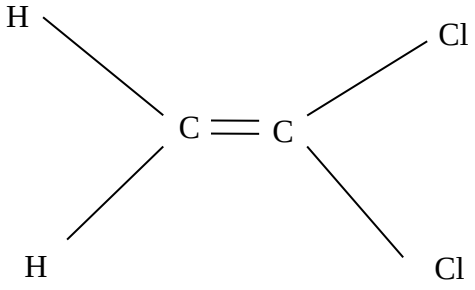
(A)



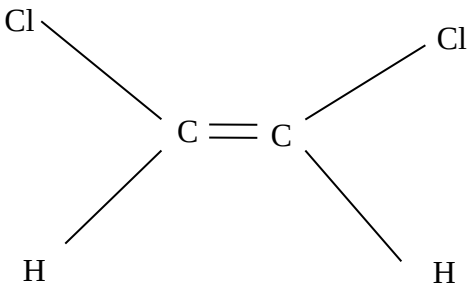
(B)



(C)



(D)



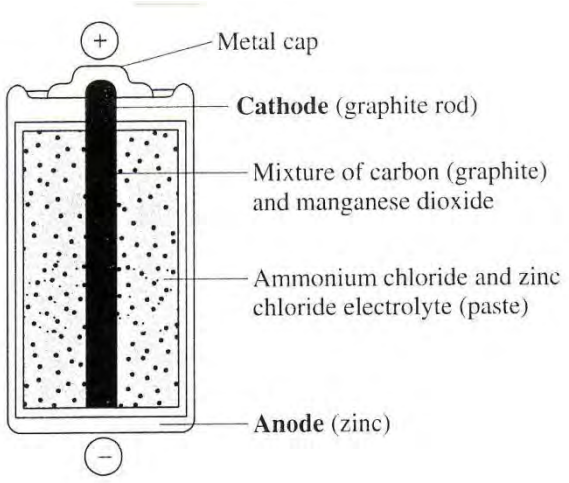
3 Select the correct value for the oxidation number of sulfur in $S_2O_3^{2-}$

(A) −2
(B) +2
(C) +4
(D) +6

4. Which of the following would be the most appropriate risk management strategy for the testing of bond saturation in hydrocarbons.

(A) Ensure you do not touch the equipment in the experiment.
(B) Pour wastes carefully down the sink so that they do not splash.
(C) Use chemicals in a fume cupboard if practicable.
(D) Heat all substances on an electric stove and not with a naked flame.

5 Select the correct alternative statement about the dry cell battery shown below.



(A) Oxidation of Mn^{4+} occurs on the surface of the graphite rod.
(B) Graphite acts as a catalyst for the oxidation of the Mn^{4+}.
(C) Oxidation of the zinc chloride occurs on the surface of the zinc anode.
(D) Oxidation of the zinc casing occurs at the anode.

6. Which of the following statements about the aqueous solutions of the oxides of Group 1 elements is valid?

(A) They are acidic.
(B) They are basic.
(C) Their pH is less than 7.
(D) Their pH is equal to 7.

7 A student tested household cleaning substances with litmus and recorded the following results:

Cleaning solution	Blue litmus	Red litmus
X	blue	red
Y	blue	blue
Z	red	red

Which of the solutions is most likely to contain ammonia?

(A) X and Y
(B) X and Z
(C) Y only
(D) Z only

8 Which of the following equations shows water behaving as an amphiprotic species?

(A) $H_2O(l) + H^+(aq) \rightarrow H_3O^+(aq)$
(B) $H_2O(l) + OH^-(aq) \rightarrow H_3O^+(aq) + O^{2-}(aq)$
(C) $2H_2O(l) \rightarrow 2H^+(aq) + 2OH^-(aq)$
(D) $2H_2O(l) \rightarrow H_3O^+(aq) + OH^-(aq)$

9 Select the most accurate value for the pH of a 0.04 M solution of H_2SO_4.

(A) 1.1
(B) 1.4
(C) 2.5
(D) 3.2

10 Polluting nitrogen oxides are produced by petrol fuelled cars in the endothermic reaction

$$N_2(g) + O_2(g) \rightarrow 2NO(g)$$

Select, from the alternatives provided, the most effective method to minimise this pollution.

(A) Increase the pressure of the system.
(B) Decrease the pressure of the system.
(C) Increase the amount of available oxygen.
(D) Decrease the temperature of the system.

11 In a particular titration, acid is measured by the pipette and alkali by the burette. Which of the following should be used to rinse the conical flask used in this titration?

(A) The acid solution
(B) The alkali solution
(C) The standard solution
(D) Distilled water

12 Select the substance which contains a coordinate covalent bond.

(A) 

(B) 

(C) 

(D) 

13 The following measurements have been made at different stages in a river as it flows from the mountains, through farms, cleared land and a city, and then to the ocean.

Sample	L	M	N	O
pH	6.5	6.6	9.2	7.6
DO (ppm)	5.7	8.7	6.0	2.2
TDS (ppm)	400	50	200	250
Turbidity (NTU)	90	4	30	65

Which of the measurements is most likely to be the clean mountain stream?

(A) L
(B) M
(C) N
(D) O

14 Which of the following procedures would be most useful to identify some unknown anions in a sample of water?

(A) Flame tests
(B) AAS
(C) IR spectroscopy
(D) Precipitation reactions

15 A simple way of detecting ozone in polluted air is to bubble the air through potassium iodide solution.

$$O_3(g) + 2H^+(aq) + 2I^-(aq) \rightarrow I_2(aq) + H_2O(l) + O_2(g)$$

What mass of iodine (in g) would be produced from 0.02g of ozone?

(A) 0.79
(B) 1.06
(C) 1.59
(D) 3.17

Chemistry

Student Number

Section I (continued)

Part B – 60 marks
Attempt Questions 16 – 26
Allow about 1 hour and 45 minutes for this part.

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (4 marks)

Explain why the chemical properties of alkanes and alkenes are very different. Outline an experiment you performed to demonstrate this difference. 4

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Question 17 (3 marks)

Using specific examples, compare addition and condensation polymerisation reactions.

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Question 18 (5 marks)

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Discuss one recent development in polymer science that alleviates the uncertainty about future sources of raw materials for current polymers.
Refer to one specific polymer and include details of how it can be made.

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Question 19 (8 marks)

A galvanic cell operating under standard conditions and using nickel as the cathode, produced an emf of 1.44 volts.

(a) Identify the element reacting as the anode and justify your choice. 2

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(b) Draw a labelled diagram of this galvanic cell. 3

2

(c) Explain what is meant by standard conditions.

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(d) Identify the oxidising agent in this cell. 1

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Question 20 (7 marks)

An environmental officer measured the pH of a lake near a zinc mine and smelter. The zinc sulfide mined was roasted in air to produce crude zinc. The pH of the lake was 5.5.

(a) Write an equation for the release of sulfur dioxide into the environment. 1

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(b) What volume of gas (at SLC) would be released per tonne (1000kg) of zinc sulfide refined? 2

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(c) Evaluate reasons for concern about the release of this gas into the environment. 4

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Question 21 (8 marks)

A data logger with a pH probe attached was used in the titration of 30mL of dilute propanoic acid with 0.010 mol L^{-1} sodium hydroxide to determine its concentration.
The following results were obtained.

Volume of NaOH added (mL)	pH	Volume of NaOH added (mL)	pH
0	5.0	14	7.7
2	5.5	15	9.0
4	5.9	16	10.3
6	6.1	18	10.6
8	6.3	20	10.9
10	6.4	22	11.0
12	6.7	24	11.1
13	7.0	26	11.2

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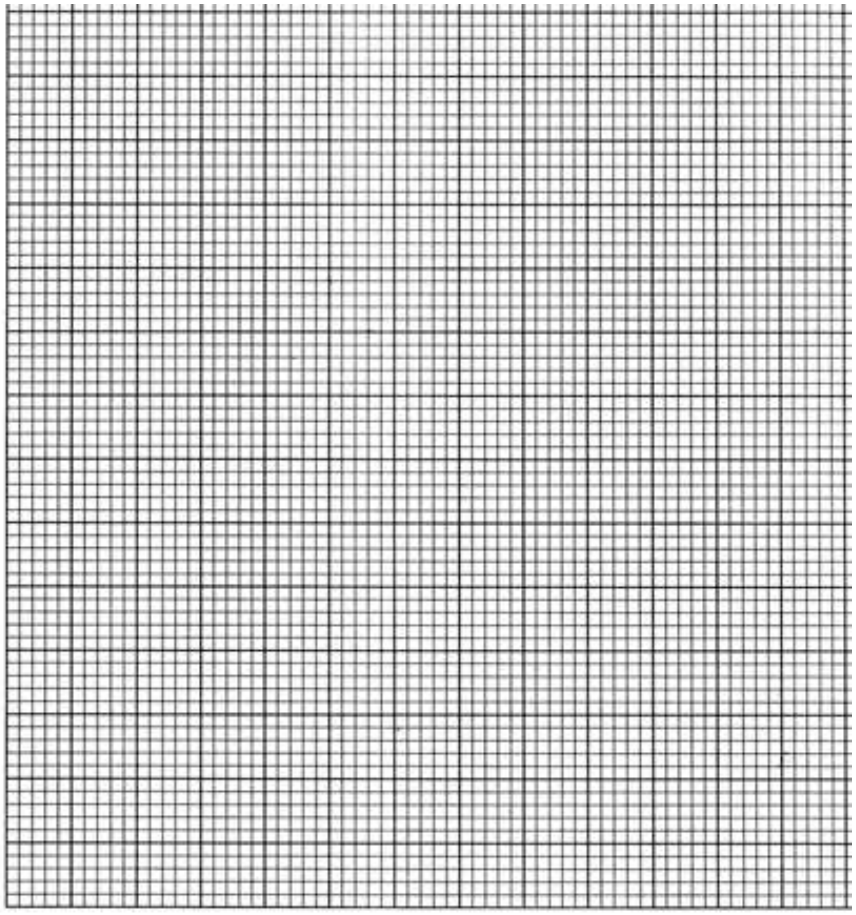
(a) Draw a graph of pH versus volume of NaOH added on the grid supplied. 3



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(b) Use the graph to determine the volume of NaOH used to reach the equivalence point 1

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(c) Propanoic acid is monoprotic. Determine the concentration of the acid from the titration results. 2

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(d) Is propanoic acid a strong or weak acid? Justify your response using two different pieces of evidence from the data and responses above. 2

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Question 22 (5 marks)

(a) Write an equation for the esterification reaction used to prepare propyl butanoate. 2

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(b) Describe the effect of using concentrated sulfuric acid on the yield and rate in this process. 2

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(c) Identify one use of esters in processed food. 1

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Question 23 (5 marks)

Explain why monitoring of the reaction vessel used in the Haber process is crucial, and describe the monitoring required.

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Question 24 (4 marks)

Some students measured the sulfate content of lawn fertiliser. The value they obtained was 68.4 % and the value quoted on the packet was 72.7 %.
Explain the chemistry involved in this analysis and one possible cause for the inaccurate result.

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Question 25 (6 marks)

As the demand for drinking water increases, it has become necessary to monitor levels of contaminants and to develop new technologies for treating impure water sources.

(a) To measure the concentration of chloride ions in a sample of water, 20.0 mL of this water was titrated with 0.0050 mol L^{-1} silver nitrate using a suitable indicator such as potassium chromate. The volume of the titre was 8.0 mL.

(i) Write an ionic equation for the precipitation reaction. 1

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(ii) Calculate the concentration of the chloride ions in ppm (mg L^{-1}). 2

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(b) Describe the design and composition of microscopic membrane filters and explain how they purify contaminated water. 3

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Question 26 (5 marks)

(a) Describe, using equations, how the compound 1,1-dichloro-1,1-difluoro methane contributes to ozone depletion. 3

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(b) During your study of ozone depletion you gathered secondary information to evaluate the effectiveness of alternative chemicals to replace CFC's. 2
Describe how you processed and analysed the gathered information.
State how you assessed the reliability of the data obtained.

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Section II

25 marks
Attempt Question 27
Allow about 45 minutes for this part.

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

Show all relevant working in questions involving calculations.

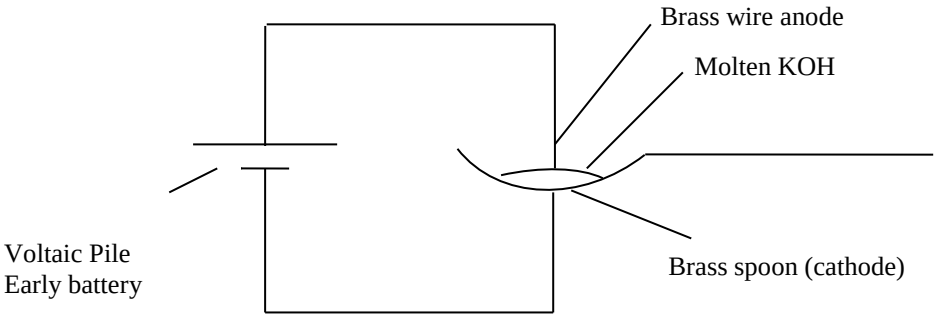
Marks

(a) To predict the extent of corrosion in wrecks, you performed first hand investigations on the effect of temperature and oxygen concentration on the rate of corrosion.

(i) Describe the use of controls in your experiment and outline the results you obtained. 3

(ii) Evaluate the use of these results in predicting the amount of corrosion occurring on the Titanic. 4

(b)



Davy was the first scientist to electrolyse molten potassium hydroxide.

(i) Write the half reaction that occurs at the cathode. 1

(ii) What is the minimum voltage that must be supplied by the Voltaic Pile for this electrolysis to occur. 1

(iii) Analyse the contribution made by Davy to understanding of electron transfer reactions. 2

(c) Corrosion of iron in a marine environment is a huge problem for many ships.

(i) Explain, using appropriate equations, the process of rusting in a marine environment. 3

(ii) Compare two different types of cathodic protection, used in the marine environment, in terms of the oxidation/reduction chemistry involved. 4

(d) Discuss conservation and restoration of marine artefacts and compare the techniques applied to two Australian maritime archaeological projects. 7

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

Question 16 (4 marks)
Explain why the chemical properties of alkanes and alkenes are very different. Outline an experiment you performed to demonstrate this difference.

- Alkenes – unsaturated or double bond **and** alkanes – sat or single bond
- Double bond more reactive
- Use of bromine water
- One decolourises it; one does not

Question 17 (3 marks)
Using specific examples, compare addition and condensation polymerisation reactions.

- 2 x examples (1 x addition, 1 x condensation)
- compare using one criteria

Question 18 (5 marks)
Discuss one recent development in polymer science that alleviates the uncertainty about future sources of raw materials for current polymers. Refer to one specific polymer and include details of how it can be made.

- Mention that currently source is petroleum which will runout
- Name biopolymer
- Organism that makes it
- Feedstock
- Other point about the polymer eg biodegradable

Question 19 (8 marks)
A galvanic cell operating under standard conditions and using nickel a the cathode, produced an emf of 1.44 volts.

(a) Identify the element reacting as the anode and justify your choice

- Calculation
- Appropriate element from table

(b) Draw a labelled diagram of this galvanic cell

- Salt bridge, anode, cathode, voltmeter
- Solutions (Al^{3t}, Ni^{2r}) and electrodes (Al, Ni)

- Diagram drawn correctly including e^- direction

(c) Explain what is meant by standard conditions

- 1.0 M solutions)
- Room temp 25°C)any 2 (none incorrect)
- Pressure 100k Pa)

(d) Identify the oxidising agent in this cell

- Ni^{2t} or nickel ions

Question 20 (7 marks)
An environmental officer measured the pH of a lake near a zinc mine and smelter. The zinc sulphide mined was roasted in air to produce crude zinc. The pH of the lake was 5.5.

(a) Write an equation for the release of sulphur dioxide into the environment

- $ZnS(s) + O_2(g) \rightarrow ZnO(s) + SO_2(g)$
- Correct products and reactants (Zn also accepted)

(b) What volume of gas (at SLC) would be released per tonne (1000kg) of zinc sulphide refined?

- $\frac{10^6 g}{97.46} \times 24.79\ L$

(c) Evaluate reasons for concern about the release of this gas into the environment

4 detailed description of formation of acid rain and its effects (at least 3) (or respiratory effects of SO_2)
3 some details missing or only two effects
2 one effect
1 something relevant, eg formation of acid rain

Question 21 (8 marks)
A data logger with a pH probe attached was used in the titration of 30mL of dilute propanoic acid with 0.010 mol L^{-1} sodium hydroxide to determine its concentration.

(a) Draw a graph of pH versus volume of NaOH added on the grid supplied.

- Plotting

- Axis title and units
- pH as NaOH

(b) Use the graph to determine the volume of NaOH used to reach the equivalence point

- if looking at right part of curve

(c) Propanoic acid is monoprotic. Determine the concentration of the acid from the titration results.

- Method eg $C_1 V_1 - C_2 V_2$
- Substitution

(d) Is propanoic acid a strong or weak acid? Justify your response using two different pieces of evidence from the data and responses above.

- (all marks for <u>justification</u> only)
- Buffering region)
- pH higher than expected for acid of that concentration)
- equivalence pt is >7) any 2

Question 22 (5 marks)

(a) Write an equation for the esterification reaction used to prepare propyl butanoate.

- Propanol + butanoic acid →Ester + <u>water</u>

(b) Describe the effect of using concentrated sulphuric acid on the yield and rate in this process.

- Rate increases due to <u>catalyst</u>
- Yield – stays same (if dehydration not mentioned)
- Yield – increases (if dehydration was mentioned

(c) Identify one use of esters in processed food.

- Flavouring agent
- Energy (as fats)
- Emulsifier

Question 23 (5 marks)

Explain why monitoring of the reaction vessel used in the Haber process is crucial, and describe the monitoring required.

- Temperature)

- Pressure)
- Catalyst) at least 3
- Reactant mixture)

- Relate conditions to rate and yield or safety

Question 24 (4 marks)
Some students measured the sulphate content of lawn fertiliser. The value they obtained was 68.4% and the value quoted on the packets was 72.7%. Explain the chemistry involved in this analysis and one possible cause for the inaccurate result.

- SO_4^{2-} precipitated from a solution of a weighed amount of fertiliser using Ba^{2+} ➔ $BaSO_4^{2-}$

- Precipitate weighed

- mass SO_4^{2-} calculated from mass of precipitate using stoichiometry

- Cause eg precipitate very fine and passes through the filter paper *or* not all sulfate precipitated because not enough barium ions were added.

Question 25 (6 marks)
As the demand for drinking water increases, it has become necessary to monitor levels of contaminants and to develop new technologies for treating impure water sources.

(a) To measure the concentration of chloride ions in a sample of water, 20.0mL of this water was titrated with 0.0050 mol L^{-1} silver nitrate using a suitable indicator such as potassium chromate. The volume of the titre was 8.0 mL.

(i) Write an ionic equation for the precipitation reaction

$Ag^+_{m)} + Cl^-_{(m)} \rightarrow Ag\ Cl_{(s)}$

(ii) Calculate the concentration of the chloride ions in ppm (mg L^{-1}).

$C_1\ V_1 = C_2\ V_2$

$0.0050 \times 0.0080 = C_2 \times 0.0200$

$C_2 = 0.0020$ mol L^{-1}

$= .0020 \times 35.45 \times 10^3$ ppm

(b) Describe the design and composition of microscopic membrane filters and explain how they purify contaminated water.

- Thin film of eg polymer with uniform holes
- Semi – permeable
- Contaminated water at high pressure passes over surface of filter and reverse osmosis ➔ clean water
- Diagram with explaining labels may be used

Question 26 (5 marks)

(a) Describe, using equations, how the compound 1,1-dichloro-1,1-difluoro methane contributes to ozone depletion.

- $C_2 F_2 Cl_2 + \rightarrow CF_2 Cl + Cl^{\cdot}$ The CFC photo dissociates in the stratosphere releasing a chlorine radical
- $Cl^{\circ} + O_3 \rightarrow Cl O^{\circ} + O_2$. The chlorine radical reacts with ozone
- $ClO^{\circ} + O^{\circ} \rightarrow Cl^{\circ} + O_2$. The ClO° radical reacts further so that the chlorine radical is again formed and is free to react with more ozone molecules.

(b) During your study of ozone depletion you gathered secondary information to evaluate the effectiveness of alternative chemicals to replace CFC's.
Describe how you processed and analysed the gathered information.
State how you assessed the reliability of the data obtained.

- Process and analysis of HCF's and HCFCl's properties using data collected from textbooks and web sites (edu. or gov. sources)
- Books & web site cross referenced for consistency ➔ reliability assessment.

27(a)

(i)

Clearly explains role of control in measuring changes in independent variable while other variables are controlled Outlines experimental set up Clearly explains results of experiment.	3
Any two of the above	2
Has some idea of controlled experiment or experimental set up Or results of experiment	1

(ii)

Clearly relates experimental results to conditions around the Titanic Predicts corrosion of Titanic Describes actual conditions (eg activity of SRB and consequent corrosion) Makes a judgement based on criteria	4
Any three of the above	3
Makes a correlation between results of experiment and Titanic and predict corrosion	2
Correctly describes some conditions at Titanic	1

27 (b)

$K^+ + e^- \rightarrow K$	1
- 0.4 – 2.94 = - 3.34 V	1
Nature of electrolyte affects product of electrolysis Role of electrolyte in galvanic cell Or any other one good relevant contribution	2

27(c)

(i)

Presence of 0_2 / H_2O/ Provide ideal condition for a galvanic cell $Fe \rightarrow Fe^{2+} + 2e^-$ oxidation stress site $½O_2 + H_2O + 2e^- \rightarrow . 2OH^-$ at anode eg site of impurities in solution $Fe^{2+} + OH^- \rightarrow Fe(OH)_2$ further oxidation $\rightarrow Fe_2O_3\ xH_2O$	3
Provides correctly at 2 of these and correctly identify anode /cathode	2
State O_2/H_2O/ water necessary for Fe $\rightarrow$ Fe_2O_3xH2O in a galvanic cell reaction	1

(i) At a site of impurities in steel eg C atoms
Cathode $½\ O_2 + H_2O + 2e \rightarrow 2\ OH^-$
At a site where there is a weakness in the metal lattice
Anode $Fe \rightarrow Fe^2 + 2e^-$
Ions travel through the ocean electrolyte
electrons through the hull

$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$
Further oxidation $\rightarrow Fe(OH)_3$ or ($Fe_2O_3 .xH_2 0$)

(ii) Cathodic Protection

Sacrificial anode (galvanic all)	An active metal eg Zn plate attached $Zn \rightarrow \mathbf{Zn^{2+} + 2e^-}$ anode sacrificed while iron hull is protected as it is cathode. Water is reduced.
Impressed current (electrolytic cell)	Inert electrodes made of eg titanium attached by an insulator to hull Inert electrode made the anode by an impressed voltage so electrolysis of water Iron hull made cathode so Fe cannot oxidise any Fe^{2+} will be reduced

4 marks for both type of protection and description.

27
(d)

- Must clearly distinguish between conservation and restoration
- Must identify 2 Australian artefacts and correctly state whether they were conserved or restored
- Must discuss chemistry of their conservation/restoration providing a reasonable outline of the processes in both artefacts.