



Student Number	
Mark /	

Chemistry Assessment

Task 3 Term 2 2011

Theory

General Instructions

- **Reading time** – 5 minutes
- **Working time** – 50 minutes
- **Write using black or blue pen**
- **Write your Student Number at the top of this page and on pages 6,7,9,11 and 13.**
- **Board-approved calculators may be used**
- **A data sheet and a periodic table are provided at the back of the paper.**

Total Marks – 41

Part A – 7 marks

- Attempt Questions (1 -7)
- Allow about 10 minutes for this part

Part B – 34 marks

- Attempt Questions (8 – 16)
- Allow about 40 minutes for this part

Part A: Multiple Choice: 7 marks
Attempt Questions (1-7)
Allow about 10 minutes for this part

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.

A B C D

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

A B C D
correct
↑

Multiple Choice

▶ **Mark your answers for the multiple choice questions on the multiple choice grid on page 6**

1. Which environmental factor would lead to increased levels of biological oxygen demand and total dissolved solids in a river?

- (A) Acid rain
- (B) Fertiliser run-off
- (C) Land clearing
- (D) Untreated sewage

2. Drinking water is treated with additives for various reasons. Which of the choices below is the most appropriate with respect to the function of the additive?

	Additive	Function
(A)	fluorine	to protect dental health of children
(B)	chlorine	to kill bacteria and other microorganisms
(C)	chloride	to kill bacteria and other microorganisms
(D)	lime $\text{Ca}(\text{OH})_2$	to decrease the pH of the water

3. Water quality can be determined by considering:

- (i) concentration of common ions, such as NO_3^- , PO_4^{3-} , Cl^-
- (ii) total dissolved solids
- (iii) hardness
- (iv) acidity
- (v) dissolved oxygen and biochemical oxygen demand

Which of these water quality tests would be most important in monitoring possible eutrophication of waterways?

- (A) (i) – (v)
- (B) (i) and (v) only
- (C) (ii) and (iii) only
- (D) (ii) – (v) only

4. The measurements of several water samples are displayed in the table below.

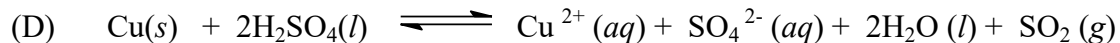
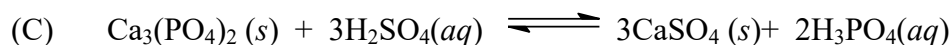
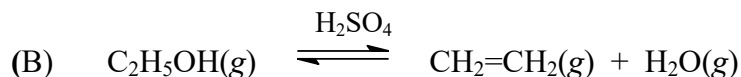
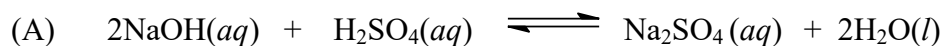
	<i>W</i>	<i>X</i>	<i>Y</i>	<i>Z</i>
Dissolved oxygen (mg/L)	12	3.0	7.0	14
Turbidity (NTU)	3.0	18	22	5.0
pH	6.8	7.0	7.1	7.0
Phosphate (mg/L)	0.030	0.20	0.020	0.50
Nitrate (mg/L)	0.030	0.50	0.020	0.20

Which water sample could be classified as the cleanest?

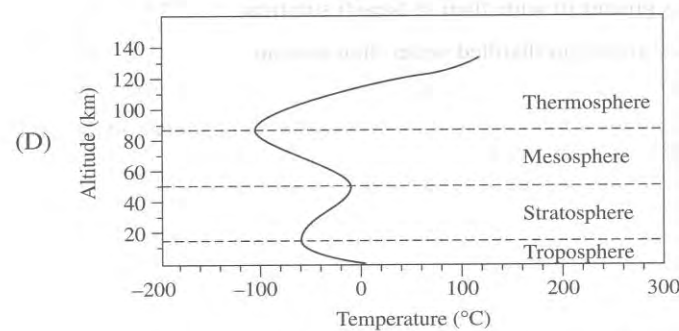
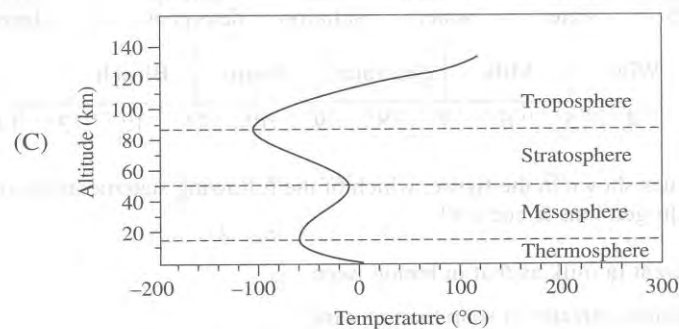
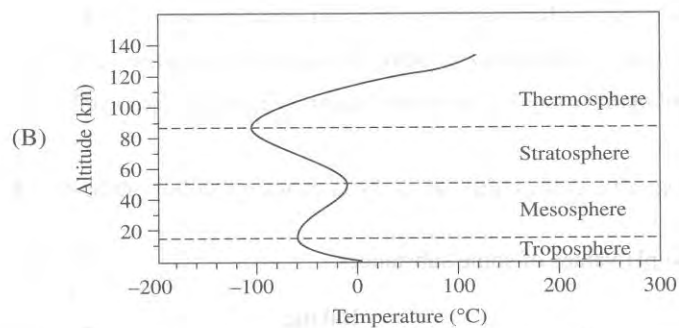
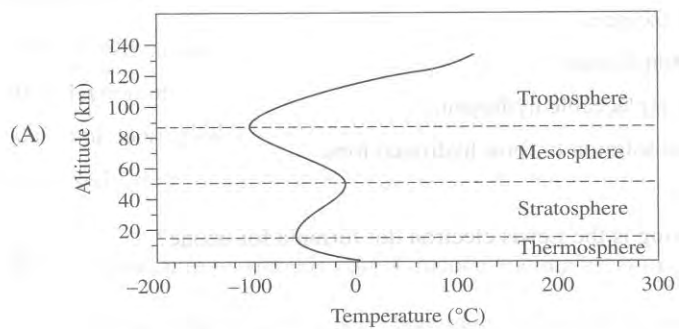
- (A) W
(B) X
(C) Y
(D) Z
5. When analysing your water sample from Lake Yerbury at Macquarie University, one of your determinations included phosphate concentration.

Which of the following statements best describes a part of your method?

- (A) The blue complex absorbed light in the spectrophotometer.
(B) The blue complex was concentrated in a warm water bath.
(C) The molybdenum light emitted the frequency of light required for AAS of the blue complex.
(D) The blue complex was diluted and analysed by titration.
6. In which of the following reactions is sulfuric acid acting as a dehydrating agent?



7. Which of the following graphs shows correctly labeled layers of the atmosphere?



Roland Smith, 2000, Conquering Chemistry, 3rd edition (C) McGraw - Hill Australia Pty Ltd.

Part A . Answer grid for multiple choice questions

- | | | | | |
|----|-----|-----|-----|-----|
| 1. | A O | B O | C O | D O |
| 2. | A O | B O | C O | D O |
| 3. | A O | B O | C O | D O |
| 4. | A O | B O | C O | D O |
| 5. | A O | B O | C O | D O |
| 6. | A O | B O | C O | D O |
| 7. | A O | B O | C O | D O |

Total:/7

Part B

Attempt Questions 8 – 16.

Allow about 40 minutes for this part

▶ Show all relevant working in questions involving calculations.

Question 8 (3 marks)

Heavy metals can enter a water supply by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers, and groundwater.

- (a) Using an example, describe what is a heavy metal. **1**

.....
.....
.....

- (b) Describe how heavy metal pollution in water can be identified. **2**

.....
.....
.....
.....

Test continues next page ▶

Question 9 (3 marks)

Microscopic membrane filters are very effective at purifying contaminated water on a small scale.

Explain how microscopic membrane filters purify contaminated water.

3

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

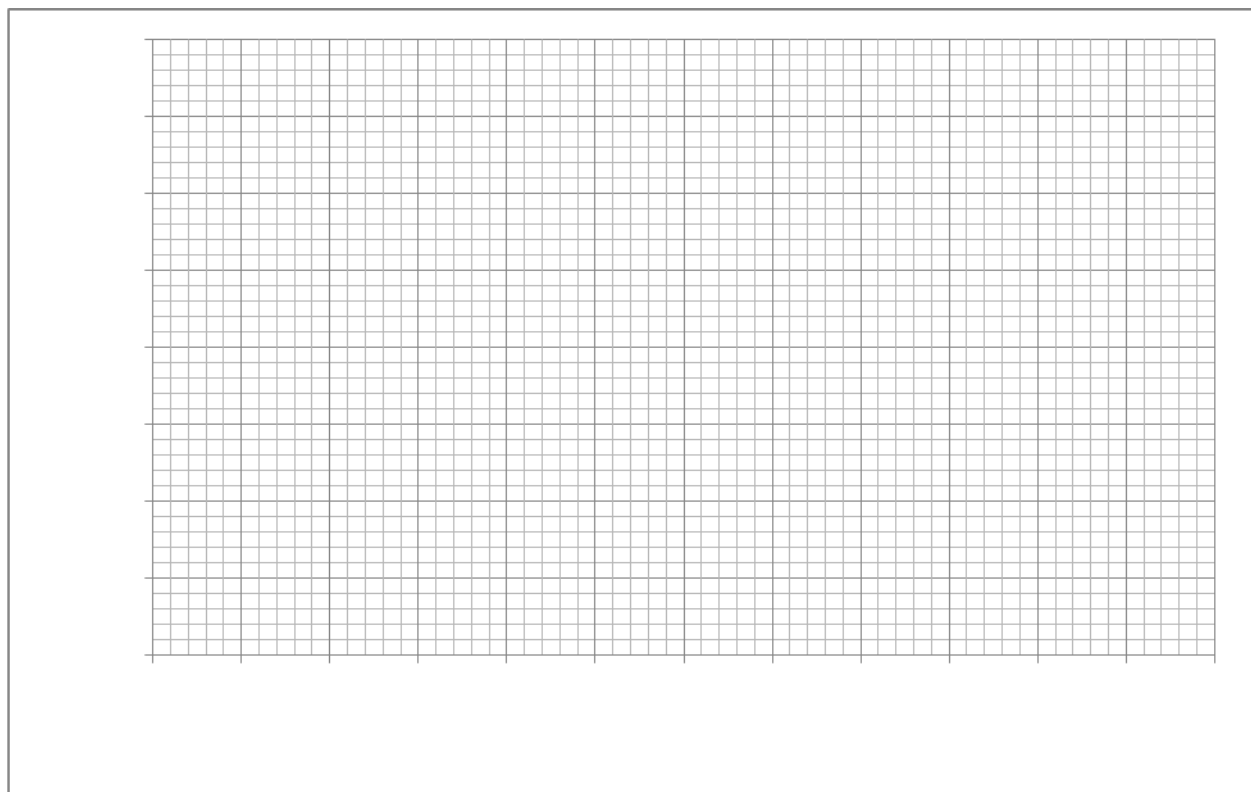
Test continues next page ▶

Question 10 (5 marks)

Elevated levels of magnesium ions and calcium ions in water bodies can cause water hardness. In an experiment to determine the concentration of calcium ions, the following standard solutions were prepared and their absorbance determined by atomic absorption spectroscopy.

Standard Ca ²⁺ solution mg/L	Absorbance Reading
0.0	0.00
10.0	0.16
20.0	0.28
30.0	0.42
40.0	0.54
50.0	0.68
Water sample	0.36

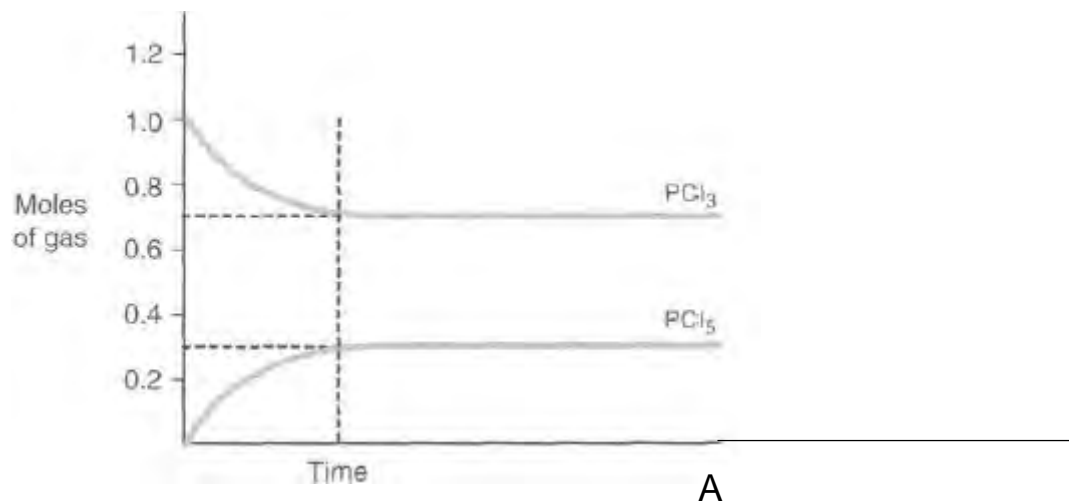
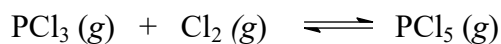
- (a) Plot and draw a calibration graph for the standard calcium ion solutions on the grid

3

Question 10 continues next page ▶

Question 12 (4 marks)

- (a) 1 mole of phosphorus trichloride is mixed with one mole of chlorine gas in a 2 L container and maintained at 30 °C. They react as shown in the equation.



Use the information in the figure above to calculate the equilibrium constant for the reaction at 30 °C

3

.....

.....

.....

.....

- (b) At time A, the pressure was increased. Sketch on the above graph how the concentrations of the reactants and product would change (only a qualitative sketch is required).

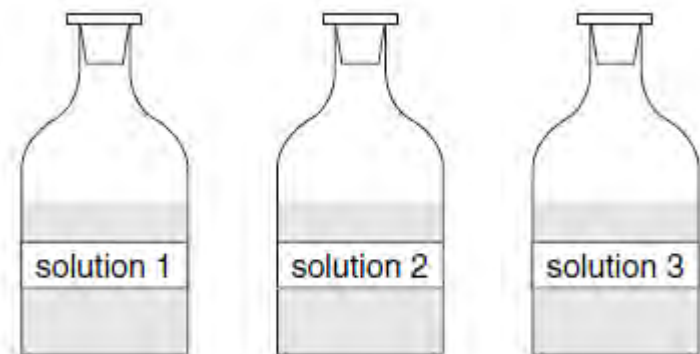
1

Test continues next page ▶

Question 13 (4 marks)

Each of the three bottles contains one of the following aqueous solutions:

- Barium nitrate
- Sodium carbonate
- Hydrochloric acid



A student mixed pairs of these solutions together and obtained the following results

Reactants	Observation
Solution 1 and solution 2	Bubbles
Solution 2 and solution 3	No reaction
Solution 1 and solution 3	White precipitate

(a) Complete the table to identify solutions 1,2 and 3.

2

Solution	Identity
1	
2	
3	

(b) Write a balanced chemical equation to represent the reaction between solutions 1 and 2.

1

.....

(b) Write a net ionic equation for the reaction between solutions 1 and 3.

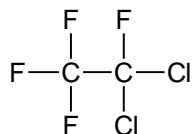
1

.....

Test continues next page ▶

Question 14 (1 mark)

What is the systematic name of the CFC in the diagram?

1

.....

Question 15 (4 marks)Draw electron-dot diagrams of O_2 and O_3 , identifying the type of bonding within each structure.**4**

O_2	O_3
--------------	--------------

Test continues next page ▶

Question 16 (5 marks)

Discuss the role of CFCs in the ozone layer, using relevant equations.

5

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

End of Theory Test



Student Number	
Mark /	

Chemistry Assessment

Task 3 Term 2 2011

Theory Answers

General Instructions for *Theory*

- Reading time 5 minutes
- Working time 50 minutes
- Write using black or blue pen
- Write your Student Number at the top of this page
- Board-approved calculators may be used

A data sheet and a periodic table are provided at the back of the paper.

Total Marks – 41

Part A - 7 marks

- Attempt Questions (1-7)
- Allow about 10 minutes for this part

Part B – 34 marks

- Attempt Questions (8-16)
- Allow about 40 minutes for this part

Part A: Multiple Choice: 7 marks

Attempt Questions (1-7)

Allow about 10 minutes for this part

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.

A B C D

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

A B C D
An arrow labeled "correct" points to the B option.

▶ **Mark your answers for the multiple choice questions on the multiple choice grid on page -----**

- Which environmental factor would lead to increased levels of biological oxygen demand and total dissolved solids in a river?
(A) Acid rain
(B) Fertiliser run-off
(C) Land clearing
(D) **Untreated sewage**
- Drinking water is treated with various additives for various reasons. Which of the choices below is the most appropriate with respect to the function of the additive?

	<i>Additive</i>	<i>Function</i>
(A)	fluorine	to protect dental health of children
(B)	chlorine	to kill bacteria and other microorganisms
(C)	chloride	to kill bacteria and other microorganisms
(D)	lime (Ca(OH) ₂)	to decrease the pH of the water

Outcomes:H11, H13

3. Water quality can be determined by considering:
- (i) concentration of common ions, such as NO_3^- , PO_4^{3-} , Cl^-
 - (ii) total dissolved solids
 - (iii) hardness
 - (iv) acidity
 - (v) dissolved oxygen and biochemical oxygen demand

Which of these water quality tests would be most important in monitoring possible eutrophication of waterways?

- (A) (i) – (v)
- (B) (i) and (v) only**
- (C) (ii) and (iii) only
- (D) (ii) – (v) only

Outcomes:H4,H11

4. The measurements of several water samples are displayed in the table below.

	<i>W</i>	<i>X</i>	<i>Y</i>	<i>Z</i>
Dissolved oxygen (mg/L)	12	3.0	7.0	14
Turbidity (NTU)	3.0	18	22	5.0
pH	6.8	7.0	7.1	7.0
Phosphate (mg/L)	0.030	0.20	0.020	0.50
Nitrate (mg/L)	0.030	0.50	0.020	0.20

Which water sample would be classified as the cleanest?

- (A) W**
- (B) X
- (C) Y
- (D) Z

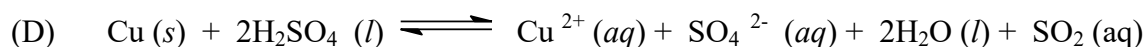
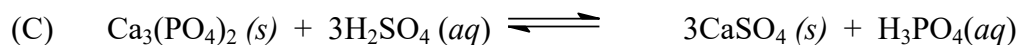
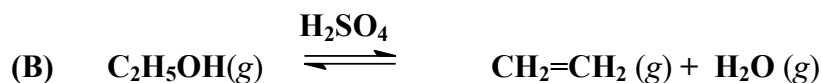
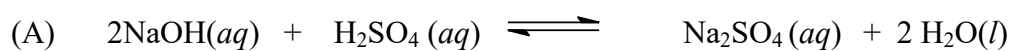
5. When analysing your water sample from Lake Yerbury at Macquarie University, one of your determinations was phosphate concentration.

Which of the following statements best describes a part of your method?

- (A) **The blue complex absorbed light in the spectrophotometer.**
(B) The blue complex was concentrated in a warm water bath.
(C) The molybdenum light emitted the frequency of light required for AAS of the blue complex.
(D) The blue complex was diluted and analysed by titration.

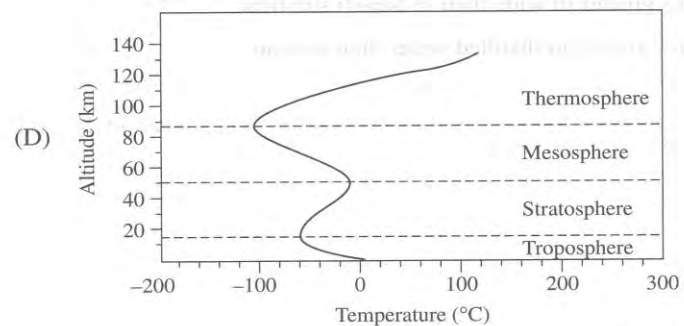
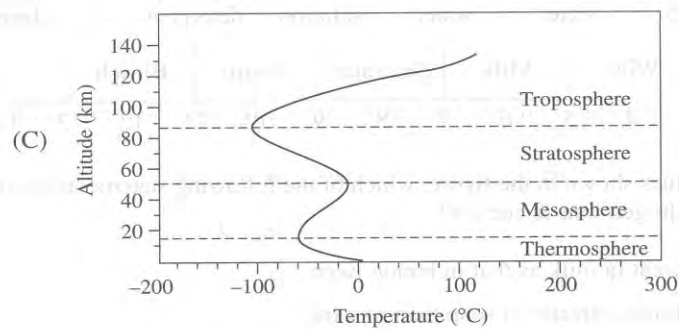
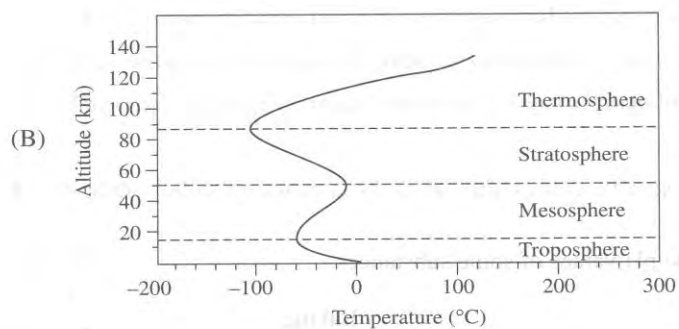
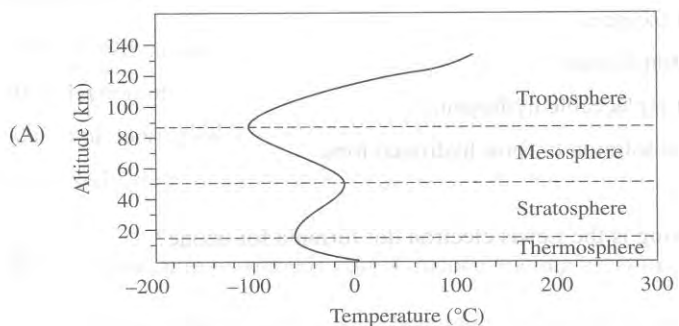
Outcomes : H3,11

6. Which of the following shows sulfuric acid acting as a dehydrating agent?



Outcomes : H10

7. Which of the following graphs shows the correct sequence for the layers of the atmosphere ?



Roland Smith, 2000, Conquering Chemistry, 3rd edition (C) McGraw - Hill Australia Pty Ltd.

Ans: D
Outcome: H2

Part A . Answer grid for multiple choice questions

Total/..

- | | | | | |
|----|-----|-----|-----|-----|
| 1. | A O | B O | C O | D • |
| 2. | A O | B • | C O | D O |
| 3. | A O | B • | C O | D O |
| 4. | A • | B O | C O | D O |
| 5. | A • | B O | C O | D O |
| 6. | A O | B • | C O | D O |
| 7. | A O | B O | C O | D • |

Total:/7

Part B Free Response Questions

Attempt Questions

Allow about 40 minutes for this part

▶ *Show all relevant working in questions involving calculations.*

Question 8 (3 marks)

MARK(S)

Heavy metals can enter a water supply by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers, and groundwater.

(a) Using an example, describe what is a heavy metal. 1

.....

.....

.....

Outcomes: H13

Sample Answer:

Heavy metals are metallic chemical elements that have a relatively high density, high atomic mass and are toxic at low concentrations, eg., Hg, Cd, Cr, Tl, Pb

<i>Criteria</i>	<i>Mark</i>
a short definition and at least one example	1

(b) Describe how heavy metal pollution in water can be identified. 2

.....

.....

.....

.....

Outcomes: H11, H13

Sample Answer:

Heavy metal pollution can be identified in water through atomic emission spectroscopy (AES) or by precipitation reactions with appropriate reagents:

AES can be used to identify heavy metal ion pollution by comparing the emission spectrum of a water sample with the emission spectrum of standards consisting of known amounts of various heavy metals.

Various electronic sensors coated with amino acids or other chelating substances reactive with heavy metals are being developed to detect heavy metals in situ.

<i>Criteria</i>	<i>Mark</i>
correct technique with good explanation of the method	2
correct technique with less than satisfactory explanation of the method	1
correct technique but no explanation	0

Question 9 (3 marks)

Microscopic membrane filters are very effective at purifying contaminated water on a small scale.

Explain how microscopic membrane filters purify contaminated water.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Sample answer:

Microscopic membrane filters are composed of polymer sheet membranes that have small holes or pores.

Water flows across the membrane surface within the filter and through the membrane. The membrane within the filter consists of fine pores or capillary-like tubes which trap the particles and microorganisms. Water flows to the inner tube devoid of particles and microorganisms.

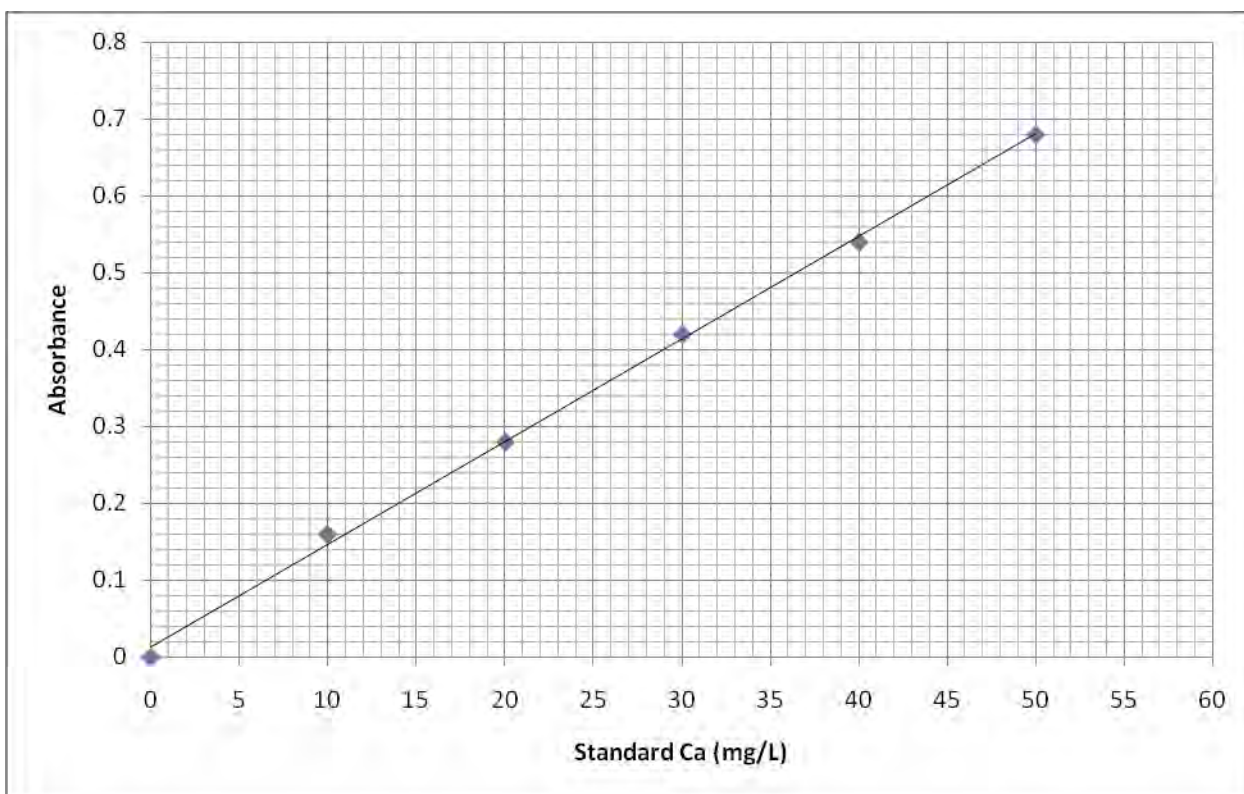
Outcome criteria	Marks
Provides one example of a membrane filter material and describes the filtering process.	2
Provides one example of a membrane filter material.	1

Question 10 (5 marks)

Elevated levels of magnesium and calcium ions in water bodies can cause water hardness. In an experiment to determine the concentration of calcium ions, the following standard solutions were prepared and their absorbance determined by atomic absorption spectroscopy.

Standard Ca ²⁺ solutions mg/L	Absorbance Reading
0.0	0.00
10.0	0.16
20.0	0.28
30.0	0.42
40.0	0.54
50.0	0.68
Water Sample	0.36

(a) Plot a calibration curve for the standard calcium solutions on the grid (3 marks)



<i>Marking criteria</i>	<i>Marks</i>
<ul style="list-style-type: none"> • <i>Correct axes</i> • <i>Correct plots</i> • <i>Line of best fit</i> 	3
<ul style="list-style-type: none"> • <i>Two of the above</i> 	2
<ul style="list-style-type: none"> • <i>One of the above</i> 	1

(b) Using the absorbance of the water sample, calculate the concentration of calcium ions in mol L⁻¹. (2 marks)

.....

.....

.....

.....

.....

Sample answers (Question 11)

More sulfuric acid is manufactured than any other inorganic compound.

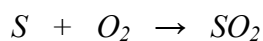
- (a) Identify one major use of sulfuric acid. (1 mark)

Manufacture of fertilizer, dehydrating agent, production of explosives, detergents, insecticides, dyes, linoleum, synthetic rubber, film, ink, cellophane, and car batteries.

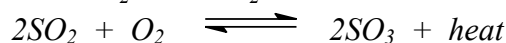
- (b) Describe the industrial process for the manufacture of sulfuric acid from its raw materials. Include relevant equations in your answer. (4 marks)

Sample answer

Roasting of sulphur in air

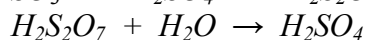


Contact process



This is an equilibrium and the forward reaction is exothermic. A compromise temperature of 450 °C is used to increase the rate so equilibrium is achieved faster and a catalyst of V₂O₅ is also used to lower the activation energy and increase the rate of the reaction

Making oleum



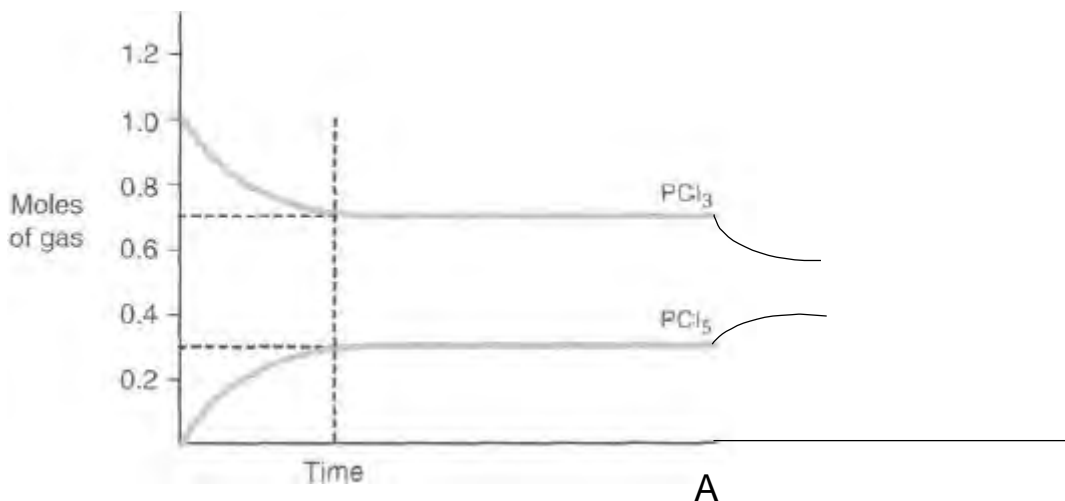
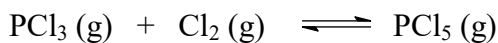
Adding SO₃ directly is dangerous as the reaction is exothermic and creates an acid mist. SO₃ is added first to sulfuric acid to make oleum and the oleum is added to water to make sulfuric acid

<i>Marking criteria</i>	<i>Marks</i>
<ul style="list-style-type: none"><i>At least 3 equations and describes steps, conditions and catalyst</i>	<i>4</i>
<ul style="list-style-type: none"><i>At least 2 equations and describes conditions and catalyst</i>	<i>3</i>
<ul style="list-style-type: none"><i>At least one equation and outlines the process</i>	<i>2</i>
<ul style="list-style-type: none"><i>Outlines the process</i>	<i>1</i>

Outcomes : H3,4,7,8,10

Question 12 (4 marks)

- (a) 1 mole of phosphorus trichloride is mixed with one mole of chlorine gas in a 2 L container and maintained at 30°C. They react as shown in the equation.



Use the information in the graph to calculate the equilibrium constant for the reaction.

.....

.....

.....

.....

- (b) At time A, the pressure was increased. Sketch on the graph how the concentrations of the reactant and product would change (only a qualitative sketch is required). (1 mark)

Sample answer

	$\text{PCl}_3(\text{g})$	+	$\text{Cl}_2(\text{g})$	\rightleftharpoons	$\text{PCl}_5(\text{g})$
Initial []	$\frac{1}{2}$		$\frac{1}{2}$		0
Used	$0.3/2$		$0.3/2$		
Equilibrium []	0.35		0.35		0.15

$$K = \frac{[PCl_5]}{[PCl_3][Cl_2]} = \frac{0.15}{0.35 \times 0.35} = 1.22$$

<i>Marking criteria</i>	<i>Marks</i>
<ul style="list-style-type: none"> • <i>Correct concentrations</i> • <i>K expression</i> • <i>Correct calculation of K</i> 	3
<ul style="list-style-type: none"> • <i>Two of the above</i> 	2
<ul style="list-style-type: none"> • <i>One of the above</i> 	1

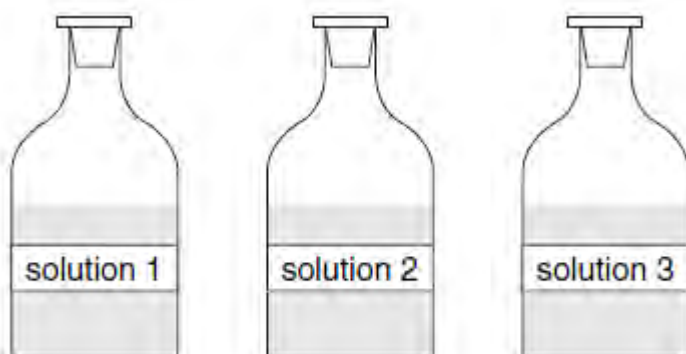
(b) At time A, the pressure was increased. Sketch on the graph how the concentrations of the reactant and product would change (only a qualitative sketch is required). (1 mark)

Outcomes :H8, H10

Question 13 (4 marks)

Each of the three bottles contains one of the following solutions:

- Barium nitrate
- Sodium carbonate
- Hydrochloric acid



A student mixed pairs of these solutions together and obtained the following results

<i>Reactants</i>	<i>Observation</i>
Solution 1 and solution 2	Bubbles
Solution 2 and solution 3	No reaction
Solution 1 and solution 3	White precipitate

- (a) Complete the table to identify solutions 1,2 and 3. (2 marks)

Solution	Identity
1	
2	
3	

- (b) Write a balanced chemical equation to represent the reaction between solutions 1 and 2.(1 mark)

.....

- (c) Write a net ionic equation for the reaction between solutions 1 and 3.(1 mark)

.....

Sample answer for Question 7

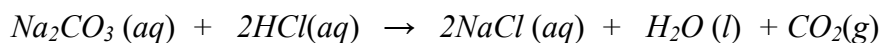
A student mixed pairs of these solutions together and obtained the following results

Reactants	Observation
Solution 1 and solution 2	Bubbles
Solution 2 and solution 3	No reaction
Solution 1 and solution 3	White precipitate

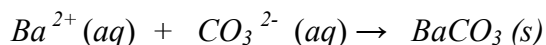
- (a) Complete the table to identify solutions 1,2 and 3. (2 marks)

<i>Solution</i>	<i>Identity</i>
<i>1</i>	<i>Na₂CO₃</i>
<i>2</i>	<i>HCl</i>
<i>3</i>	<i>Ba(NO₃)₂</i>

- (b) Write a balanced chemical equation to represent the reaction between solutions 1 and 2.(1 mark)



- (c) Write a net ionic equation for the reaction between solutions 1 and 3.(1 mark)

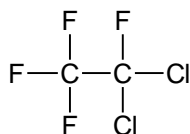


<i>Marking criteria</i>	<i>Marks</i>
<ul style="list-style-type: none"> • 3 correct 	2
<ul style="list-style-type: none"> • 2 or 1 correct 	1

Outcomes : H10

Question 14 (1 mark)

What is the systematic name of the CFC in the diagram? (1 mark)



Outcome:H9

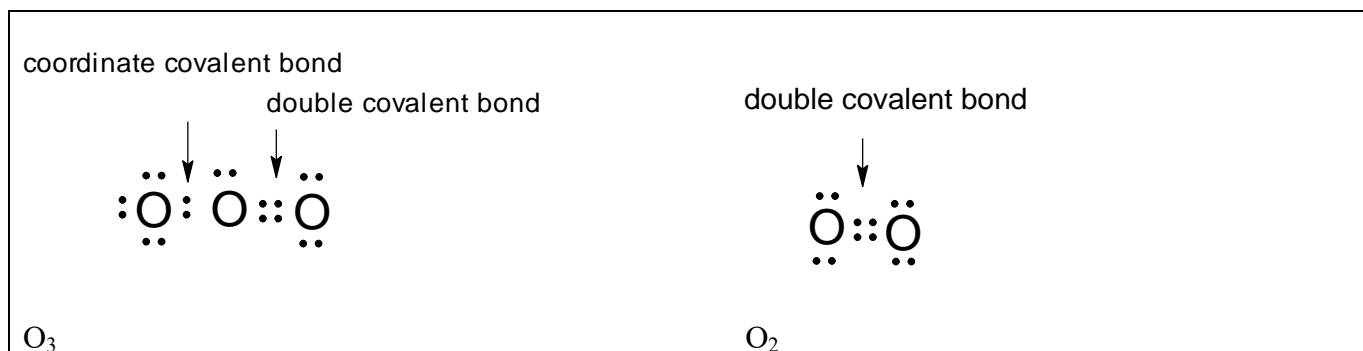
Sample Answer : 1,1- dichloro – 1,2,2,2 – tetrafluoroethane

Marking guidelines

<i>Marking criteria</i>	<i>Mark</i>
Correct identification of systematic name of molecule	1

Question 15 (4 marks)

Draw an electron-dot diagram of O₂ and O₃ , identifying the type of bonding within each structure. (4 marks)



Outcome:H6

Sample Answer :

Correct electron dot diagram for O₂ showing one double-bond and correct electron dot diagram for O₃ showing one double-bond and one co-ordinate covalent bond.

Marking Guidelines

<i>Marking criteria</i>	<i>Marks</i>
Complete and correct e-dot diagrams for O ₂ and O ₃ showing all electrons and labeling(identifying) the double covalent bonds and coordinate covalent bonds in each molecule	4
One of the above	3
Two of the above missing	2
Three of the above missing	1

Question16 (5 marks)

Discuss the role of CFCs in the ozone layer, using relevant equations. (5 marks)

.....

.....

.....

.....

.....

.....

.....

.....

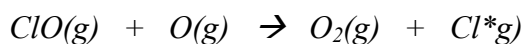
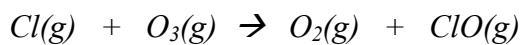
Outcome:H4

Sample Answer :

CFCs are chemically inert molecules which move from the troposphere into the stratosphere where UV radiation produces Cl radicals



The chlorine radical with its unpaired electron is very reactive and catalyses the decomposition of ozone :



The chlorine radical is now able to react with more ozone molecules. The process damages the stratosphere by reducing the ozone concentration allowing UVb radiation to pass through into the troposphere.

Marking Guidelines

Marking criteria	Mark
Thorough, sequential and complete explanation including relevant equations(3) showing the production of Cl, the Cl reacting with O ₃ and the release of Cl to continue destroying more ozone molecules.	
One of the above missing or incomplete	
Two of the above missing or incomplete	
Three of the above missing or incomplete	

End of Theory Test