

Section A. MULTIPLE CHOICE QUESTIONS (3 marks)

INSTRUCTIONS

Use the multiple choice answer sheet on page 3.

Select the alternative A, B, C or D that best answers the question. Fill in the response square 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 this by writing the word *correct* and drawing an arrow as follows:

A B C D

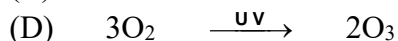
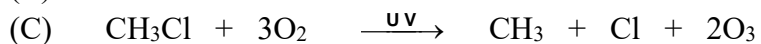
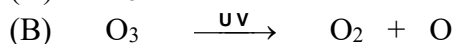
correct

Section A: Multiple Choice

1. Which of these electron dot structures represents ozone?



2. Which of these equations shows the interaction of ozone with UV radiation in the upper atmosphere?



3. Identify the only factor that changes the value of the equilibrium constant (K) for a given reaction.

(A) pressure

(B) volume

(C) temperature

(D) concentration

Section A: Multiple Choice Answer Sheet

1. A ○ B ○ C ○ D ○
2. A ○ B ○ C ○ D ○
3. A ○ B ○ C ○ D ○

Section B: Short Answer Questions *Answer the questions in the spaces provided. Show all relevant working in questions involving calculations*

Question 5. (5 marks)

Chemical engineers employed by the Vistron Corporation have done pilot studies of ammonia synthesis to determine the ideal operating conditions at the plant. Some engineering data is shown in the table...

| | | | | | |
|----------------------------|-----------------------------------------------|-----|-----|------|------|
| Varied Conditions | Pressure (atm) | 350 | 600 | 1000 | 1000 |
| | Temperature (°C) | 500 | 600 | 600 | 550 |
| Constant Conditions | Catalyst = Fe₃O₄ | | | | |
| Observed Results | Percentage Yield of NH₃ | 19 | 29 | 46 | 51 |
| | Time to reach equilibrium (min.) | 10 | 2.0 | 2.0 | 6.0 |

- (a) Give an equation for the industrial production of ammonia **(1 mark)**

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- (b) Analysing the data, explain the lowest value in percentage yield. **(1 mark)**

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Question 5 continues next page

(c) Analysing the data, explain the lowest value in time. **(1 mark)**

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(d) Discuss why the monitoring of the ammonia reaction vessel is crucial. **(2 marks)**

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Question 6 (5 marks)

(a) Much of the chemistry of the upper atmosphere is determined by the reactivity of the oxygen species present, O (free radical), O₂ and O₃. Arrange these oxygen species in order of increasing reactivity. **(1 mark)**

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(b) Halons are more potent ozone destroyers than CFCs. Identify the original source of the halons in the troposphere. **(1 mark)**

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Question 6 continues next page

(c) Consider this list of haloalkanes...



(i) Identify which of these compounds is an effective replacement for CFCs. . (1 mark)

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(ii) Name the compound identified in (i). (1 mark)

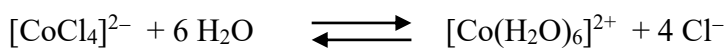
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(iii) Draw an isomer of the compound identified in (i). (1 mark)

Question 7

(2 marks)

A novelty humidity indicator consists of a doll which changes colour from blue to pink depending on the level of water vapour in the atmosphere. The colour change can be considered to be based on the equilibrium:



BLUE

PINK

On a very dry day (i.e. low humidity), what colour is the doll? Explain your answer.

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Question 8

Discuss the issues associated with shrinking world resources with regard to one identified natural product that is not a fossil fuel, identifying the replacement materials used and/or current research in place to find a replacement for the named material. **(4 marks)**

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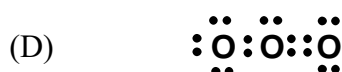
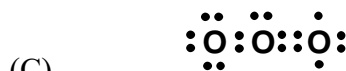
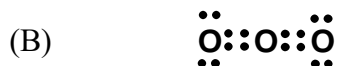
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End of Part I Theory 

Section A: Multiple Choice

Which of these electron dot structures represents ozone?

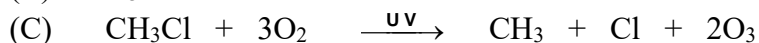
1.



Outcome – H6

Answer – D

2. Which of these equations shows the interaction of ozone with UV radiation in the upper atmosphere?



Outcomes – H4, 8

Answer – B

3. Identify the only factor that changes the value of the equilibrium constant (K) for a given reaction.

(A) pressure

(B) volume

(C) temperature

(D) concentration

ANS: C

Section B: Short Answer Question

Question 5.

(5 marks)

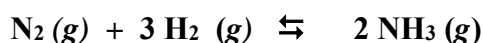
Chemical engineers employed by the Vistron Corporation have done pilot studies of ammonia synthesis to determine the ideal operating conditions at the plant. Some engineering data is shown in the table...

| | | | | | |
|---------------------|-------------------------------------------|-----|-----|------|------|
| Varied Conditions | Pressure (atm) | 350 | 600 | 1000 | 1000 |
| | Temperature (°C) | 500 | 600 | 600 | 550 |
| Constant Conditions | Catalyst = Fe ₃ O ₄ | | | | |
| Observed Results | Percentage Yield of NH ₃ | 19 | 29 | 46 | 51 |
| | Time to reach equilibrium (min.) | 10 | 2.0 | 2.0 | 6.0 |

Outcomes – H7, 8

Answers:

- (a) Give an equation for the industrial production of ammonia. (1 mark)



- (b) Analysing the data, explain the lowest value in percentage yield. (1 mark)

The minima percentage yield is due to the low setting of the pressure at 350 atm. According to Le Châtelier's Principle the equilibrium would shift to the left which would lower NH₃ production.

- (c) Analysing the data, explain the lowest value in time. (1 mark)

The minima in time is due to the high setting of the temperature at 600°C. The higher the temperature the faster the reaction rates (forward and reverse) and the arrival of equilibrium. (1 mark)

- (d) Discuss why the monitoring of the ammonia reaction vessel is crucial. (2 marks)

- (i) **Maintaining the correct temperature and pressure is important for efficient production of ammonia.**
- (ii) **Excessive temperatures can damage the catalyst.**
- (iii) **The high temperature and pressure can promote gas leaks in the system causing severe burns, explosion and poisoning.**
- (iv) **Strict plant maintenance is essential to prevent gas leaks due to corrosion, stress cracks, bad seals. All safety equipment must be working properly.**

► *One mark for one reason + one mark for adequate detail = 2 marks*

Question 6**(5 marks)****Outcomes** – H4, 5**Answers**

- (a) Much of the chemistry of the upper atmosphere is determined by the reactivity of the oxygen species present, O (free radical), O₂ and O₃. Arrange these oxygen species in order of increasing reactivity.

(1 mark)

- (b) Halons are more potent ozone destroyers than CFCs. Identify the original source of the halons in the troposphere.

(1 mark)

Halons were commonly used in fire extinguishers.

(1 mark)

- (c) Consider this list of haloalkanes...



- (i) Identify which of these compounds is an effective replacement for CFCs. **(1 mark)**

**(1 mark)**

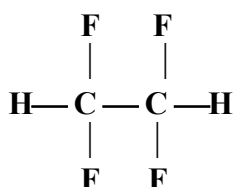
- (ii) Name the compound identified in (i).

(1 mark)

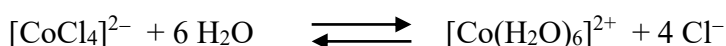
1,1,1,2-tetrafluoroethane

(1 mark)

- (iii) Draw an isomer of the compound identified in (i).

(1 mark)**Question 7****(2 marks)**

A novelty humidity indicator consists of a doll which changes colour from blue to pink depending on the Level of water vapour in the atmosphere. The colour change can be considered to be based on the equilibrium:



BLUE

PINK

On a very dry day (i.e. low humidity), what colour is the doll? Explain your answer. **(2 marks)**

On a very dry day, equilibrium will shift left to produce more H₂O and [CoCl₄]²⁻ (Le Chatelier's) so the doll will be blue

Question 8

Discuss the issues associated with shrinking world resources with regard to one identified natural product that is not a fossil fuel, identifying the replacement materials used and/or current research in place to find a replacement for the named material. **(4 marks)**

Marking guidelines

| Criteria | Mark(s) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Identifying one natural product that is not a fossil fuel <u>AND</u> two issues associated with shrinking world resources <u>and</u> either the replacement material used <u>or</u> current research to find replacement | 4 |
| Identifying one natural product that is not a fossil fuel and two of either an issue associated with shrinking world resources or identifying the replacement material used <u>or</u> current research in place to find a replacement | 3 |
| Identifying one natural product that is not a fossil fuel <u>and</u> either one issue associated with shrinking world resources or identifying the replacement material used <u>or</u> current research in place find a replacement | 2 |
| Identifying one natural product that is not a fossil fuel <u>or</u> one issue associated with shrinking world resources | 1 |

End of Part I TheoryAns 