

SECTION A

Answer **ALL** questions. Write your answers in the spaces provided.

1 (a)

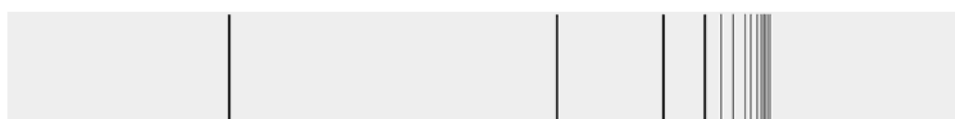
The electronic arrangement of a silicon atom is (2, 8, 4).

Suggest how you would use experimental data available from scientific literature to establish the above electronic arrangement.

(3 marks)

1 (b)

The figure below shows the Lyman series of the atomic emission spectrum of hydrogen.



Frequency →

(i) What do the spectral lines represent?

(1 mark)

- (ii) With the help of appropriate drawing, explain why the spectral lines become progressively closer to each other as frequency increases.

(2 marks)

- (iii) Suggest how the ionization enthalpy of hydrogen can be obtained from its atomic emission spectrum.

(3 marks)

- (iv) Suggest one application of atomic emission spectroscopy in chemical analysis.

(1 mark)

2 (a)

(i) What is the first ionization enthalpy of an element?

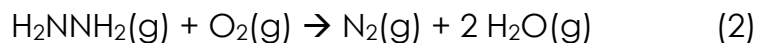
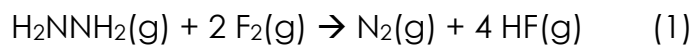
(1 mark)

(ii) Sketch a graph to show the variation in first ionization enthalpy of the elements from helium to neon.

(3 marks)

2 (b)

Rocket propellants consist of fuels and oxidizers. When hydrazine is used as a fuel, fluorine or oxygen can be used as the oxidizer. The reactions involved can be represented by the following equations:



You are provided with the following bond enthalpy data:

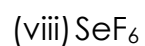
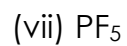
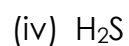
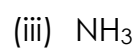
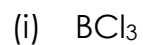
Bond	Bond enthalpy / kJ mol ⁻¹
N–N	163
N≡N	945
N–H	390
F–F	158
F–H	565
O=O	498
O–H	464

Calculate the enthalpy changes, in kJ mol⁻¹, for reactions (1) and (2).

(6 marks)

3 (a)

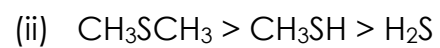
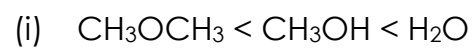
Draw the three-dimensional structure for each molecule below, showing the lone electron pair(s), if any, of the central atom. State the shape of each molecule.



(8 marks)

3 (b)

Account for the order of boiling point for the two series of compounds below:



(3 marks)

4 (a) (i)

(1) Write the ground state electronic configuration of a chromium atom.

(2) Draw the structure for the dichromate(VI) ion.

4 (a) (ii)

(1) Write the ground state electronic configuration of a manganese atom.

(2) Draw the structure for the permanganate(VII) ion.

(3 marks)

4 (b)

Explain why the atomic radius of potassium (0.227 nm) is significantly greater than that of copper (0.128 nm).

(2 marks)

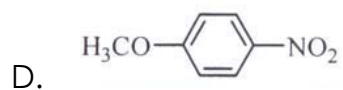
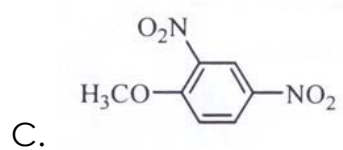
5 (a)

Answer the following multiple-choice questions:

(i) Which of the following compounds is the most reactive methylating agent?

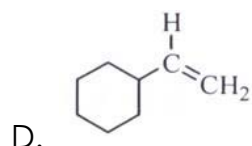
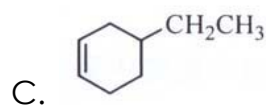
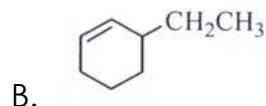
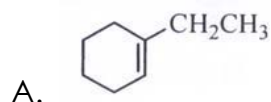
A. CH_3Cl

B. CH_3I



5 (a)

(ii) Which of the following compounds is most reactive towards HCl?



(iii) Which of the following statements concerning the hydrogenation of propene is INCORRECT?

- A. The hydrogenation is an exothermic process.
- B. The hydrogenation occurs in the presence of a catalyst at room temperature.
- C. The H-H bond is weak to allow the hydrogenation to occur.
- D. Propane is less energy rich than the starting materials.

(iv) Which of the following are greenhouse gases?

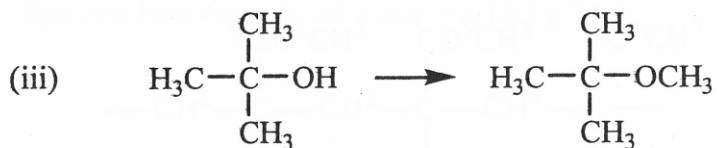
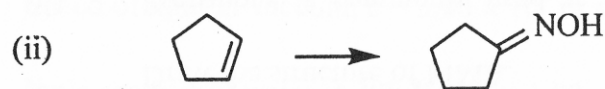
- (I) Water vapour
- (II) Methane
- (III) Ozone

- A. (I) and (II) only
- B. (I) and (III) only
- C. (I) and (II) only
- D. (I), (II) and (III) only

(4 marks)

5 (b)

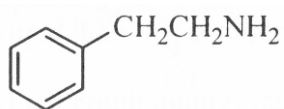
Outline a synthetic route, with *not more than four steps*, to accomplish each of *the* following transformations. For each step, give the reagent(s), conditions and the structure of the organic product.



(9 marks)

6 (a)

β -Phenylethylamine (PEA) functions as a neurotransmitter and appears to create excited feelings and moods.



PEA

Suggest a route with no more than five steps for the synthesis of PEA from methylbenzene.

(5 marks)

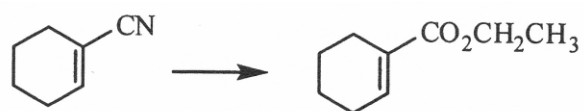
6 (b)

Suggest a route with no more than four steps for the synthesis of butane-1,4-diamine from cyclohexene.

(3 marks)

6 (c)

Suggest a synthetic route, with no more than three steps, for the following conversion:



(3 marks)

SECTION B

7. A student proposed a method to determine the concentration of citric acid in a sample of orange juice by titration with standard potassium hydroxide solution. The method proposed consists of the following experimental procedures:

1. Prepare a standard potassium hydroxide solution by dissolving a known mass of potassium hydroxide pellets in distilled water and then make it up to 100 cm³.
2. Transfer a known volume of the sample of orange juice to a clean conical flask.
3. Fill a burette, which has been well rinsed with distilled water, with the standard potassium hydroxide solution.
4. Titrate the orange juice in the flask with the potassium hydroxide solution using methyl orange as the indicator.
5. Using this titration result, calculate the concentration of citric acid in the sample.

Point out four inappropriate practices in the method. Explain why they are inappropriate and suggest corrections for them.

(12marks)

8 (a)

- (i) Outline the principles about the use of carbon-14 dating in the estimation of the age of an ancient fossil specimen.

(2 marks)

- (1) A wood sample from a fossil has an activity of 8.5 counts per gram of carbon per minute. A similar piece of modern wood has an activity of 15.3 counts per gram of carbon per minute. Estimate the age of the fossil.

(Half life for the decay of carbon-14 = 5730 years.)

(3 marks)

8. (b)

Without giving any experimental detail, outline what measurements have to be taken in order to determine the activation energy of a reaction.

(3 marks)

SECTION C

Answer **ONE** question only, and write your answers in the **AL(D)** Answer Book.

Marks will be allocated approximately as follows:

Chemical knowledge	50%
Organization	30%
Presentation (including use of language)	20%

Use equations, diagrams and examples where appropriate.

The examiners are looking for the ability to analyze, to evaluate and to express ideas.

9. Write an essay on the chemistry of buffer and its applications in daily life.

(20arks)

10. Write an essay on the factors affecting the rate of reactions and discuss the uses of chemical kinetics.

(20 marks)

END OF PAPER