

Part A – Multiple Choice (15 marks):

Attempt Questions 1 – 15

Allow about 25 minutes for this part

Use the answer grid to record your answer.

Question 1

Which one of the following is an example of an equilibrium system?

- (A) Burning propane gas in a barbeque.
- (B) A saturated solution of sodium chloride.
- (C) Reacting magnesium with oxygen in a Bunsen burner.
- (D) The production of glucose by photosynthesis.

Question 2

Which type of bond forms between the monomers that react together to form nylon polymers?

- (A) Ester
- (B) Hydrogen
- (C) Ionic
- (D) Peptide

Question 3

What is the role of the flame in the atomic absorption spectrometer?

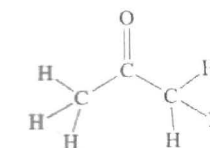
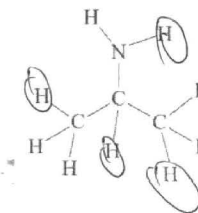
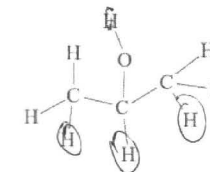
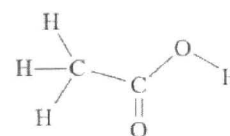
- (A) The flame vaporises the sample to be analysed.
- (B) The flame burns off all parts of the sample other than the metal ions.
- (C) The flame causes outer shell electrons to be excited to higher energy states.
- (D) The flame heats the sample so it can be aspirated into the machine.

Question 4

The spectroscopy information for an organic molecule is given below.

Number of peaks in ^{13}C NMR	2
Number of sets of peaks ^1H NMR	3
Greatest m/z of the mass spectrum	60
Infra-red (IR) spectrum	An absorption peak appears at 3350 cm^{-1}

Which molecule does this information represent?



Question 5

Which statement accurately represents Le Chatelier's principle?

- (A) Nothing can change the equilibrium constant.
- (B) If a system is at equilibrium and some change is made in the conditions, the equilibrium constant changes in a way that counteracts the effect of the change.
- (C) The concentrations of reactants and products must remain equal no matter what changes are made to the system.
- (D) If a system is at equilibrium and some change is made in the conditions, a net reaction occurs in the direction that partially counteracts the effects of the change.

Question 6

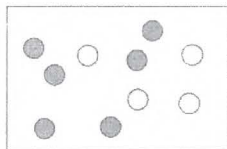
Which of the following has the homologous series in order of increasing polarity (reading left to right)?

- (A) Alcohols, alkanes, carboxylic acids
- (B) Alcohols, carboxylic acids, alkanes
- (C) Alkanes, alcohols, carboxylic acids
- (D) Alkanes, carboxylic acids, alcohols

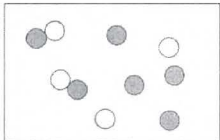
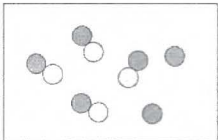
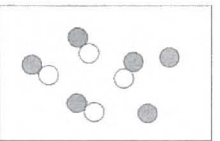
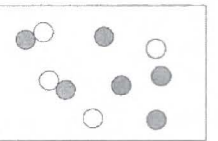
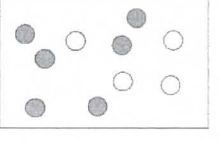
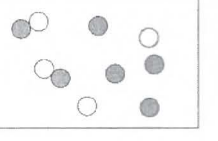
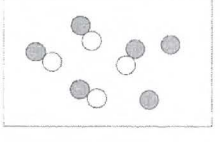
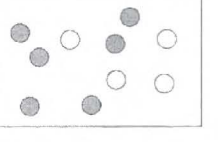
Question 7

The particle  reacts with particle  to form the molecule . The system comes to an equilibrium.

The diagram shows the initial reactants.



Which combination of diagrams best represents this reaction in a dynamic equilibrium and a static equilibrium system?

	Dynamic	Static
(A)		
(B)		
(C)		
(D)		

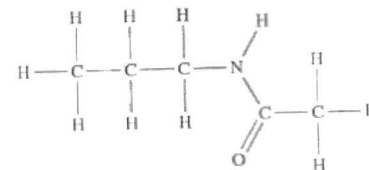
Question 8

Which of the following ions cannot be identified using complexation reactions?

- (A) Ag^+
- (B) Cu^{2+}
- (C) K^+
- (D) Fe^{3+}

Question 9

The molecule shown below could be formed from a condensation reaction between which of the following reactants?



- (A) Ethanoic acid and propan-1-amine
- (B) Ethanamine and propanoic acid
- (C) Ethanoic acid and propanamide
- (D) Ethanol and propan-1-amine

Question 10

Cetyl trimethyl ammonium bromide is the common name for a surfactant molecule. Its condensed structural formula is $\text{CH}_3(\text{CH}_2)_{12}\text{CH}_2\text{N}(\text{CH}_3)_3^+\text{Br}^-$

Select the true statement about the surfactant.

- (A) The surfactant is anionic and can be used in dishwashing liquids.
- (B) The surfactant is produced from biomass and is readily biodegradable.
- (C) The surfactant is weakly lathering in water and can be used to create stable emulsions in house paint.
- (D) The surfactant is a cationic surfactant that can be used in hair conditioners.

Question 11.

A student carried out an investigation into the behaviour of hydrated cobalt(II) chloride when it was heated in an open test tube. The following extract is from the rough notes written by the student:

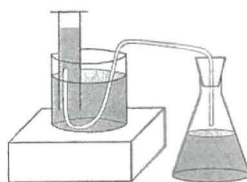
1. A few spatulas of hydrated cobalt(II) chloride were put into a test tube. The cobalt(II) chloride was a pink solid.
2. The test tube was heated carefully using a Bunsen burner flame. When heated, the cobalt(II) chloride gave off a vapour.
3. The solid was allowed to cool. When cooled, the remaining solid was blue.
4. Water was added to the solid. The solid became pink, and the test tube became warm.

Based on the information given, what should the student conclude?

- (A) The procedure shows a reversible reaction.
- (B) The procedure shows an equilibrium reaction.
- (C) Cobalt(II) chloride is an ionic substance.
- (D) Cobalt(II) chloride decomposes when heated.

Question 12

An investigation was carried out to determine if the amount of glucose in solution affected the rate of fermentation at 30°C. The equipment shown below was used to measure the amount of carbon dioxide produced over time from fermenting aqueous solutions containing 0%, 5%, 10% and 15% glucose and 5 g of starch powder.



Which of the following identifies the experimental variables?

	Independent	Dependent	Controlled
(A)	Volume of gas produced	Glucose concentration	Mass of starch, temperature
(B)	Mass of starch, temperature	Mass of starch	Volume of gas produced
(C)	Glucose concentration	Volume of gas produced	Mass of starch, temperature
(D)	Mass of starch	temperature	Glucose concentration

Question 13

Calcium nitrate thermally decomposes to form calcium oxide, nitrogen dioxide and oxygen. The table lists the standard enthalpies of formation and standard entropies for reactants and products.

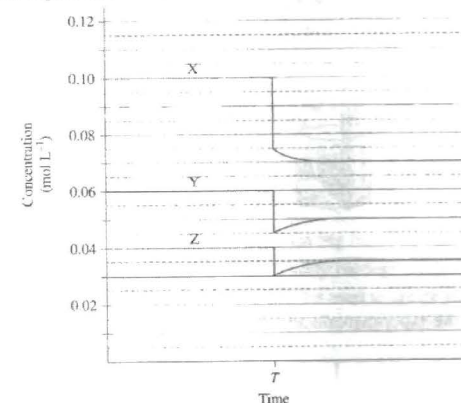
	$\text{Ca}(\text{NO}_3)_2(\text{s})$	$\text{CaO}(\text{s})$	$\text{NO}_2(\text{g})$	$\text{O}_2(\text{g})$
$\Delta_f H^\circ (\text{kJ mol}^{-1})$	-938	-635	33	0
$\Delta S^\circ (\text{J mol}^{-1} \text{K}^{-1})$	193	38	240	205

At what temperature will the reaction change from being non spontaneous to spontaneous?

- (A) 8.63 K
- (B) 8.63 °C
- (C) 863 °C
- (D) 863 K

Question 14

Three gases X, Y and Z were mixed in a closed container and allowed to reach equilibrium. A change was imposed at time T and the equilibrium was re-established. The concentration of each gas is plotted against time.

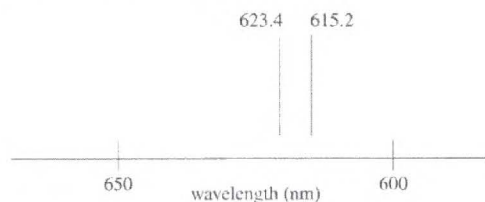


Which reaction does the graph represent?

- (A) $\text{X}(\text{g}) + \text{Y}(\text{g}) \rightleftharpoons 2\text{Z}(\text{g})$
- (B) $2\text{X}(\text{g}) \rightleftharpoons \text{Y}(\text{g}) + \text{Z}(\text{g})$
- (C) $2\text{X}(\text{g}) \rightleftharpoons \text{Y}(\text{g}) + 3\text{Z}(\text{g})$
- (D) $\text{X}(\text{g}) \rightleftharpoons \text{Y}(\text{g}) + \text{Z}(\text{g})$

Question 15

A section of the emission spectrum of a mercury lamp is shown.



Light at 623.4 nm and 615.2 nm from the mercury lamp was passed through a sample of water containing mercury, and the intensities were then measured by a detector.

$I(x \text{ nm})$ = intensity of light at a wavelength of $x \text{ nm}$ from the lamp.

$I_d(x \text{ nm})$ = intensity of light at a wavelength of $x \text{ nm}$ at the detector.

Which of the following pairs of intensities can be used in the determination of the amount of mercury in the water sample using atomic absorption spectroscopy (AAS)?

- (A) $I(615.2 \text{ nm})$ and $I_d(615.2 \text{ nm})$
- (B) $I(615.2 \text{ nm})$ and $I_d(623.4 \text{ nm})$
- (C) $I(615.2 \text{ nm})$ and $I(623.4 \text{ nm})$
- (D) $I_d(615.2 \text{ nm})$ and $I_d(623.4 \text{ nm})$

Assessment continues next page

Part B – Written Response (60 marks)

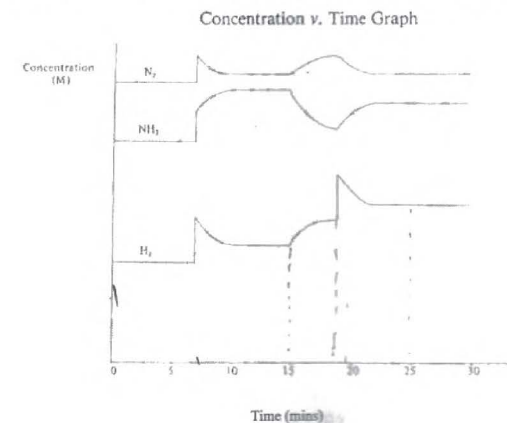
Attempt questions 16 – 27

Allow about 1 hour and 50 minutes for this part

Use the space provided to answer the following questions.

Question 16 (6 marks)

The production of ammonia from nitrogen and hydrogen is an exothermic process. Nitrogen, hydrogen and ammonia are in equilibrium in a reaction vessel at 500°C . Changes are made to the conditions of the system after 7 minutes, 15 minutes and 19 minutes. The effects of these changes are represented graphically below.



a) Suggest what particular change has been made at

- i) 7 minutes
- ii) 15 minutes
- iii) 19 minutes
- iv) 25 minutes

b) Explain why the value of the equilibrium constant for the reaction $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$, is less after the 15 minute mark than the initial value at time = 0

Question 17 (2 marks)

Distinguish between open and closed systems and relate their difference to equilibrium systems.

2

Question 19 (6 marks)

During your study of Chemistry you investigated what factors affect equilibrium and how. Using an equilibrium reaction of your own choosing, describe the relationship between collision theory and reaction rate, and how your chosen equilibrium reaction is affected by these concepts.

6

Question 18 (5 marks)

"If you want to make a reasonably large sample of a small ester like ethyl ethanoate, you can gently heat a mixture of ethanoic acid and ethanol in the presence of concentrated sulfuric acid, and distill off the ester as soon as it is formed."

- a) Explain how this procedure ensures a "~~rea~~sonably large" sample of the ester.

2

- b) In terms of the structure and bonding of the species in this reaction, explain why the ester can be distilled from the mixture.

3

Question 20 (4 marks)

A student performed an experiment to crack oil. He tested different fractions collected by placing 1 mL of bromine water in each sample. With the use of diagrams describe the two types of results he could obtain, and explain what these results would indicate about the structure of each fraction.

Question 21 (4 marks)

A pond of water was suspected to be contaminated by lead (II) ions. A chemistry student collected a sample of water from the pond for analysis.

One half of the sample was analysed by adding a solution of NaCl. No precipitate formed so the student concluded that there was no contamination by lead ions.

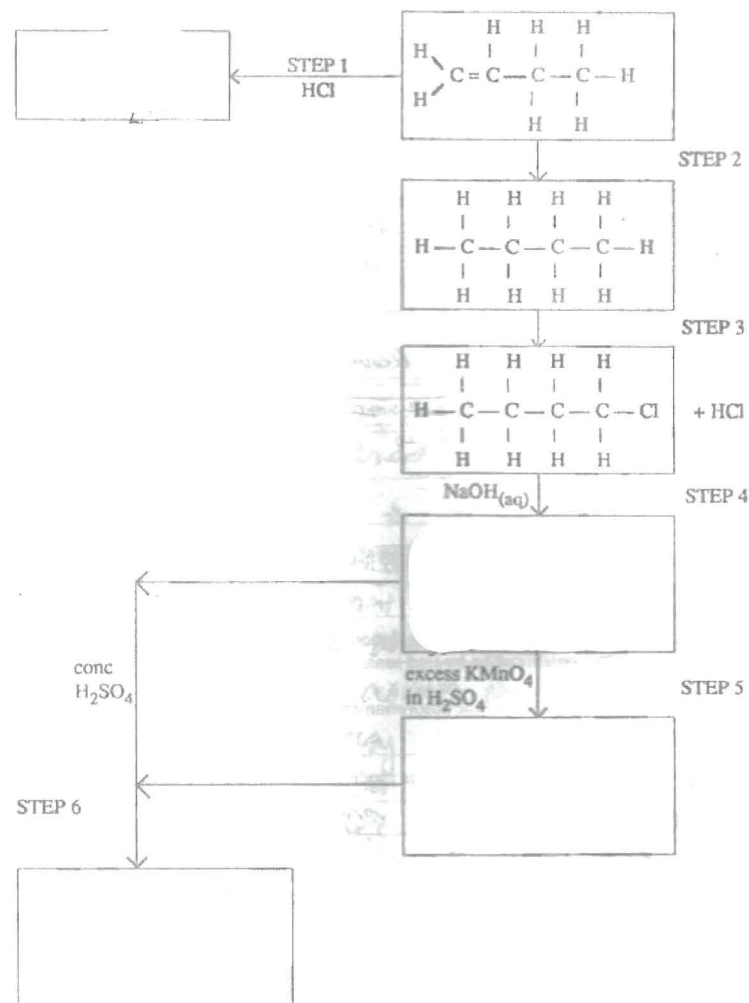
The other sample was analysed using atomic absorption spectroscopy, AAS. This analysis concluded that there was contamination by 1.5 ppm of lead.

Explain reasons why these two methods of analysis produced such different results and conclusions.

Questions 22 (7 marks)

Below is flowchart representing a reaction sequence commencing with the carbon compound but-1-ene.

On the next page answer the questions related to the flowchart.

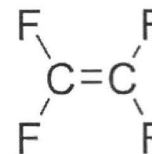


Question 22 (continued)

- (a) Name and draw the structural formula for the compound formed in Step 1.
- (b) Identify the conditions required for Step 3.
- (c) Name and draw the structural formula for the compound formed in Step 4.
- (d) Name and draw the structural formula for the compounds formed in Step 5 and Step 6.
- (e) In the space below write a balanced chemical equation for the reaction involved in Step 5

Question 23 (6 marks)

The structure of a commercially significant monomer is shown.



- (a) Identify the monomer.

1

- (b) Draw a 3 monomer structure that represents the polymer made from the monomer in part (a).

1

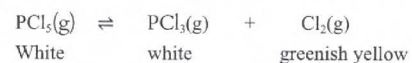
- (c) “The uses of polymers are dependent on their properties.”

4

With reference to the above statement, compare the polymer made from the monomer in part (a) with Low Density Polyethene (LDPE).

Question 24 (6 marks)

Phosphorus pentachloride decomposes to form the products as indicated in the reaction below.



The equilibrium constant (K_{eq}) for this reaction is 1.62×10^{-1} at 250°C .

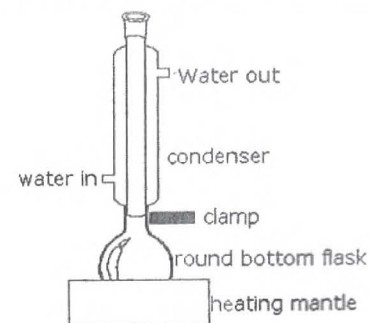
a) Write the equilibrium expression for this reaction. 1

b) 2.085 g phosphorous pentachloride was placed in a 500 mL flask and the temperature of the system was raised to 250°C . The concentration of chlorine after a minute was found to be $0.0165 \text{ mol L}^{-1}$. Using calculations, determine whether this system is at equilibrium? 3

c) How could you use the physical property provided with the above reaction to determine whether the equilibrium has not been reached and when equilibrium has been reached? 2

Question 25 (3 marks)

The equipment below can be used in the laboratory for organic synthesis.



Explain why a heating mantle and refluxing is commonly used in organic synthesis.

3

Question 26 (7 marks)

Sulfur dioxide is often used as a preservative in food and drink. The sulfur dioxide content in dried apricots can be determined through gravimetric analysis. For this to happen the sulfur dioxide is first converted to sulfate via reacting the sulfur dioxide with hydrogen peroxide as represented in the following equation



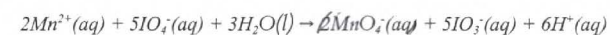
The reaction goes to completion. The sulfate is then used to determine the mass of sulfur dioxide in dried apricots.

Describe a procedure to determine the mass of sulfur dioxide in dried apricots. In your procedure you are to include a mechanical way to ensure that all sulfur dioxide is released from the dried apricots as well as justifications for any reagents or techniques proposed.

Question 27 (4 marks)

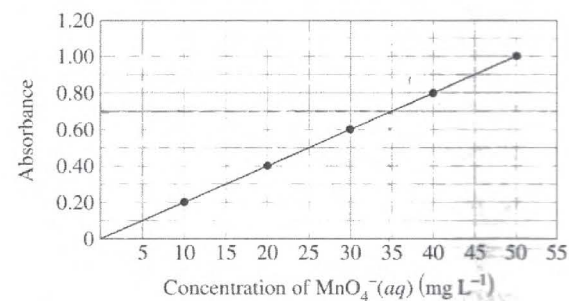
The manganese content in a 12.0 g sample of steel was determined by measuring absorbance of permanganate (MnO_4^-) using the following process.

The steel sample was dissolved in nitric acid and the $\text{Mn}^{2+}(\text{aq})$ ions produced were oxidised to MnO_4^- by periodate ions, IO_4^- (aq), according to the following equation.



The resulting solution was made up to a volume of 1.00 L, then 20.0 mL of this solution was diluted to 100.0 mL. The absorbance at 525 nm of the resulting solution was 0.70.

A calibration curve for MnO_4^- (aq) was constructed and is shown below.



Calculate the percentage by mass of manganese in the steel sample.