ZIAUDDIN UNIVERSITY
EXAMINATION BOARD

Chemistry Model Paper 2 2025

Time Allowed: 1 hour 45 minutes
Total Marks: 65

You must bring a soft pencil (preferably type B or HB), a clean eraser, and a dark blue or black pen.

Before attempting the paper, write your name, candidate number, centre name, and centre number clearly in the designated spaces.

Instructions for Candidates

- All questions are compulsory.
- Read each question carefully before answering.
- You may use a simple calculator if needed.
- You should show all your working and use appropriate units.
- Do not use an erasable pen or correction fluid.
- Avoid writing over any barcodes printed on the paper.

Information for Candidates

- This paper consists of a total of **65 marks**.
- The number of marks for each question or part question is shown in brackets [ ].
- A copy of the periodic table will be provided with this paper.

Please read all questions carefully and follow the instructions exactly to ensure your responses are properly evaluated.

Answer all questions. Show all working where appropriate.

Question 1 (10 marks)

Hydrogen iodide decomposes according to the equation:

$$\mathbf{2HI(g) \rightarrow H_2(g) + I_2(g)}$$

Standard enthalpy changes of formation:

- HI(g): +26 kJ mol^{-1}
- H_2(g): 0 kJ mol^{-1}
- I_2(g): +62 kJ mol^{-1}

(a) Calculate the enthalpy change ΔH for the reaction:

(Use ΔH = ΣΔHf(products) – ΣΔHf(reactants)) [3]

(b) Define entropy and explain why entropy changes are important in determining spontaneity. [3]

(c) At 298 K, the entropy change ΔS = +125 J K^{-1} mol^{-1}.

Calculate ΔG and state whether the reaction is feasible.
(Use $\Delta G = \Delta H - T\Delta S$.) [4]

Question 2 – Redox (9 marks)
A student investigates the reaction between acidified manganate(VII) and iron(II) ions.

$$\mathbf{MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O}$$

(a) Assign oxidation numbers to Mn in MnO_4^- and Mn^{2+}. [2]

(b) Identify:
(i) the oxidising agent :_____
(ii) the reducing agent:_____ [2]

(c) A titration uses 25.00 cm^3 of 0.0200 mol dm^{-3} $KMnO_4$.
Calculate the concentration of Fe^{2+} in a 250 cm^3 flask. [3]

(d) Explain why $KMnO_4$ does not require an indicator. [1]

(e) Suggest one source of systematic error in this titration. [1]

Question 3 (14 marks)

Consider the equilibrium:

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$$

Colourless ⇌ Brown gas

(a) State Le Chatelier's principle. [2]

(b) Predict and explain the colour change when temperature is increased. [3]

(c) At 350 K, Kc = 0.36.
A container has 0.400 mol N_2O_4 and 0.100 mol NO_2 in 1 dm^3.
Calculate whether the mixture is at equilibrium. Compute Qc and compare with Kc. [5]

(d) Explain why catalysts do not affect the position of equilibrium. [2]

(e) Suggest why industrial equilibria often operate at moderate temperatures. [2]

Question 4 (15 marks)

(a) Draw a labelled Maxwell–Boltzmann distribution and show the effect of increased temperature. [3]

(c) The rate constant k increases from 0.035 to 0.070 when temperature increases by 10 °C.
Calculate the Q_{10} value. [2]

(d) Suggest two experimental methods to measure the rate of hydrogen peroxide decomposition. [4]

(e) Explain how a catalyst affects the rate of decomposition of hydrogen peroxide. [3]

Question 5 (8 marks)
1-chloropropane reacts with aqueous NaOH to form an alcohol.

(a) Name the mechanism for the reaction between 1-chloropropane and aqueous NaOH [1]

(b) Using curly arrows, outline the mechanism. [3]

(c) Explain why iodoalkanes react faster than chloroalkanes. [2]

(d) Predict the major organic product when 2-bromopropane reacts with alcoholic KOH.[2]

Question 6 (9 marks)

(a) State how IR spectroscopy distinguishes alcohols from alkanes. [2]

(b) A mass spectrum shows a molecular ion peak at m/z = 74.
Suggest the molecular formula. [2]

(c) The NMR spectrum shows:
– A quartet integrating to 2H
– A triplet integrating to 3H
Identify the structure of the alcohol. [3]

(d) Describe one chromatographic method that can be used to separate alcohols. [2]

Chemistry Model Paper II 2025

Marking Scheme Total Marks: 65

General Marking Principles

• Award marks according to the detailed mark scheme.

• Give credit for correct alternative answers where appropriate.

• Units must be included where required.

• Allow error carried forward (ecf) where appropriate.

1(a)	$\Delta H = [0 + 62] - [2 \times 26] = 62 - 52 = +10$ kJ mol^{-1} • Substitution into formula [1] • Correct calculation [1] • Correct sign and unit [1]	3
1(b)	• Entropy: measure of disorder/randomness • Spontaneity depends on both ΔH and ΔS • Reference to Gibbs free energy	3
1(c)	• Convert ΔS to kJ: 125 J = 0.125 kJ [1] • ΔG = 10 – (298 × 0.125) = –27.25 kJ [2] • Negative ΔG → feasible [1] .	4
2(a)	• Mn in $MnO4^-$ = +7; • Mn^{2+} = +2	2
2(b)	• Oxidising agent: $MnO4^-$ • Reducing agent: Fe^{2+}	2
2(c)	• Moles $KMnO_4$ = 0.0200 × 0.02500 = 5.00×10^{-4} mol • Moles Fe^{2+} = 5 × moles $KMnO_4$ = 2.50×10^{-3} mol • Concentration Fe^{2+} = 0.0100 mol dm^{-3}	3
2(d)	Self-indicating (purple to colourless)	1
2(e)	Example: burette reading error / parallax / incomplete transfer	1
3(a)	System shifts to oppose change	2
3(b)	• Forward reaction endothermic; • increase T shifts right; • darker brown	3
3(c)	• (c) Qc = (0.100^2) / 0.400 = 0.025 [2] • Compare with Kc = 0.36 [1] • Qc < Kc → shifts right [2]	5
3(d)	• Catalyst lowers activation energy equally both directions; • no change in position	2
3(e)	Compromise between rate and yield / energy cost	2
4(a)	Correct axes; curve; higher T curve lower peak and shifted right	3

4(b)	More molecules exceed Ea; exponential increase	3
4(c)	$Q_{10} = 2$	2
4(d)	Any two methods: gas syringe; mass loss; titration; pressure sensor	4
4(e)	Alternative pathway; lowers Ea; more successful collisions	3
5(a)	Nucleophilic substitution (SN2)	1
5(b)	Curly arrow from OH^-; C–Cl bond breaks; correct product	3
5(c)	C–I bond weaker; better leaving group	2
5(d)	Propene (elimination)	2
6(a)	Alcohol: broad O–H stretch ~3200–3600 cm^{-1}; alkane lacks	2
6(b)	Mr = 74 → $C_4H_{10}O$	2
6(c)	Ethanol (CH3CH2OH)	3
6(d)	Gas chromatography or paper chromatography; brief description	2