Instructions

Answer the following questions in the space provided in this Response Booklet. You are expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner. Your steps and assumptions leading to a solution must be written in this Response Booklet. Answers must include units where appropriate and be given to the correct number of significant figures. For questions involving calculations, full marks will NOT be given for providing only an answer.
1. **(4 marks)**

Consider the following values for a catalyzed reaction that goes to completion:

\[
\text{PE(products)} = 250 \text{ kJ} \\
E_a = 175 \text{ kJ} \\
\Delta H = +50 \text{ kJ}
\]

Sketch a PE diagram for this reaction on the grid provided, then use a dotted line to show how removing the catalyst would change the PE diagram.
2. **(4 marks)**

Consider the following equilibrium:

\[ \text{CCl}_4(\text{g}) \rightleftharpoons \text{C(s)} + 2\text{Cl}_2(\text{g}) \]

A student added 2.40 mol \( \text{CCl}_4 \) to a 2.00 L flask and monitored the \( [\text{Cl}_2] \). The following graph was produced.

Calculate the value of \( K_{eq} \).
3. **(4 marks)**

A 0.15 g sample of solid PbF$_2$ is recovered from 300.0 mL of its saturated solution.

What is the $K_{sp}$ of PbF$_2$?
4. **(3 marks)**

Complete the Brønsted–Lowry acid base equation below and predict whether reactants or products will be favoured at equilibrium, and justify your answer.

\[ \text{HCO}_3^- + \text{H}_3\text{C}_6\text{H}_5\text{O}_7 \rightleftharpoons \text{______________________________} \]
5. (5 marks)

Calculate the pH of 0.45 M $\text{H}_2\text{CO}_3$. Start by writing the predominant equilibrium equation.
6. (3 marks)

The following two experiments were conducted:

- Titration A: a strong base was titrated with a strong acid.
- Titration B: a weak base was titrated with a strong acid.

How does the pH at the equivalence point of Titration B compare with the pH at the equivalence point of Titration A? Explain.
7. **(4 marks)**

Balance the following in basic solution:

\[
I_2 + NO_3^- \rightarrow NH_3 + H_3IO_6^{2-} \quad \text{(basic)}
\]
8. **(3 marks)**

Draw and label the parts of an electrolytic cell capable of copper plating an inert carbon electrode.