AP CHEMISTRY • EXERCISE SHEET

9.4 Thermodynamic and Kinetic Control

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

Objective

Build the skills to answer exam questions on **thermodynamic vs kinetic control**.

You must be able to:

- distinguish **thermodynamic favorability** ($\Delta G < 0$) from **kinetic** speed
- explain why a favorable reaction can still be slow
- link a slow favorable reaction to a high **activation energy**

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

Two separate questions

- **Thermodynamics** (ΔG) asks: *will* it happen (is it favorable)?
- **Kinetics** (E_a) asks: *how fast* will it happen?

A reaction can be favorable ($\Delta G < 0$) but extremely **slow**.

A worked example

Diamond $\rightarrow$ graphite has $\Delta G < 0$ (favorable), yet diamonds do not visibly change —the activation energy is enormous, so the rate is effectively zero.

Why favorable can be slow

A large **activation-energy barrier** blocks the reaction even when the products are lower in free energy. A catalyst can speed it up without changing ΔG.

The takeaway

"Favorable" (spontaneous) does **not** mean "fast". Both a negative ΔG and a surmountable E_a are needed for a reaction to proceed noticeably.

2 Practice

Now apply the methods above.

2.1 What does a negative ΔG tell you? [1]

2.2 What controls how fast a reaction goes? [1]

2.3 Can a favorable reaction be slow? [1]

3 Exam-style questions

3.1 A reaction with $\Delta G < 0$ that proceeds very slowly is limited by [1]

- **A** thermodynamics
- **B** a high activation energy (kinetics)
- **C** a negative ΔH
- **D** a positive entropy

3.2 The conversion of diamond to graphite has $\Delta G < 0$ but is not observed.

(a) State whether it is thermodynamically favorable. [1]

(b) Explain why it does not happen at a noticeable rate. [2]

3.3 Explain how a catalyst can make a favorable-but-slow reaction proceed, and what it does **not** change. [2]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **9.4 Thermodynamic and Kinetic Control** lesson on the **Learn** page;
- read the **Thermodynamic and Kinetic Control** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 The reaction is thermodynamically favorable (spontaneous).

2.2 The activation energy (kinetics).

2.3 Yes.

3.1 B —a high activation energy (kinetics).

3.2 (a) Yes ($\Delta G < 0$). (b) The activation energy is extremely high, so almost no molecules can cross the barrier and the rate is effectively zero.

3.3 A catalyst lowers the activation energy, providing a faster pathway; it does **not** change ΔG (the favorability).