Getting Started (15 mins)

Hook: Have you ever noticed how some things happen fast, like striking a match, while others are slow, like rust forming on a bike? Chemical reactions happen at different speeds! Today, we're going to be chemical speed detectives.

Introduction: Introduce the concept of **reaction rate** – how quickly reactants are converted into products. Ask the student: 'If you were a chemical engineer designing a factory to produce a valuable chemical, would you generally want your main reaction to be fast or slow? Why?' (Discuss efficiency, cost, control).

Background - Collision Theory: Briefly explain that for a reaction to occur, reactant particles must collide with enough energy (activation energy) and in the correct orientation. Discuss the main factors engineers consider to control reaction speed:

- **Temperature:** Hotter particles move faster and collide more often and with more energy.
- **Concentration:** More particles in a space mean more frequent collisions.
- **Surface Area:** More area exposed allows more points for collisions (think dust explosion vs. log fire).
- **Catalysts:** Substances that speed up reactions without being used up (like enzymes in our bodies).

Today, we'll investigate temperature!

The Experiment: Racing Alka-Seltzer (25 mins)

Safety First! Wear safety goggles.

Setup:

1. Label three clear cups: 'Cold', 'Room Temp', 'Warm'.
2. Measure and pour the same amount of water (e.g., 150 mL or about 2/3 cup) into each cup.
3. **Cup 1 (Cold):** Add some ice cubes to the water. Let it chill for a few minutes. Use the thermometer to measure the temperature, record it, and then remove the ice just before adding the tablet.
4. **Cup 2 (Room Temp):** Use water straight from the tap. Measure and record its temperature.
5. **Cup 3 (Warm):** Carefully add a small amount of hot water to tap water to achieve a warm (NOT boiling - around 40-50°C or 100-120°F is good) temperature. Measure and record the temperature.
6. Prepare your stopwatch/timer. Create a data table in your notebook:

   Data Table: Effect of Temperature on Reaction Time

   - Cup | Water Temperature (°C or °F) | Time for Tablet to Dissolve (seconds)
   - Cold | [Record Temp] | [Record Time]
   - Room Temp | [Record Temp] | [Record Time]
   - Warm | [Record Temp] | [Record Time]

Procedure:

1. Get ready with the timer. Drop one whole Alka-Seltzer tablet into the 'Cold' cup.
2. Start the timer *immediately*.
3. Watch carefully. Stop the timer precisely when the tablet has completely dissolved and all fizzing stops.
4. Record the time in your data table.
5. Repeat steps 1-4 for the 'Room Temp' cup.
6. Repeat steps 1-4 for the 'Warm' cup.

Analyzing the Results (15 mins)

Discussion:

- Look at your data table. Which temperature resulted in the fastest reaction (shortest time)? Which was the slowest?
- Describe the relationship you observed between water temperature and the time it took for the tablet to dissolve.
- Explain *why* this happened using Collision Theory. (Hint: Think about how fast the water molecules were moving at different temperatures and how this affected their collisions with the tablet).
- **Think like an Engineer:** Imagine this fizzing reaction was producing a gas needed in a factory. How could you use temperature control to produce the gas faster if needed? What if the reaction was producing too much heat and needed to be slowed down for safety? (Discuss heating/cooling systems in industrial reactors).
- (Optional) Can you think of how to calculate the 'rate'? A simple way is Rate ≈ 1 / Time. Calculate this for each trial. Does higher temperature give a higher or lower rate value?

Conclusion & Connection (5 mins)

Summarize the key finding: Increasing temperature generally increases the rate of a chemical reaction because it leads to more frequent and more energetic collisions between reactant particles. This is a fundamental principle used by chemical engineers every day to design, optimize, and control chemical processes safely and efficiently, from making medicines to producing fuels.

Extension Activities (Optional)

- **Surface Area Challenge:** Design and conduct a similar experiment to test the effect of surface area. Use two cups of room temperature water. Put a whole tablet in one and a crushed tablet (carefully break it up *before* adding) in the other. Time both. Which is faster? Why?
- **Concentration Idea (Conceptual):** How might you test the effect of concentration using something like dissolving sugar or salt? (More concentrated solution might dissolve *slower* if it's nearing saturation, but for reaction rates, higher reactant concentration usually means faster rate).
- **Real-World Research:** Research one industrial chemical process (e.g., Haber-Bosch process for ammonia, catalytic cracking for gasoline) and identify how chemical engineers control reaction rates (temperature, pressure, catalysts) in that process.