

CHEMISTRY WITH PROFESSOR IRVING EPSTEIN

TALKING POINTS

KNOWLEDGE

1. What is a nonlinear process?
2. What chemical reaction is an example of a nonlinear reaction?

COMPREHENSION

3. Summarise why it is difficult to understand nonlinear processes.

APPLICATION

4. Draw a graph with time on the X axis and distance on the Y axis for an object moving at steady speed. Discuss how the graph would change if this were a nonlinear process.

ANALYSIS

5. What does 'chance favours the prepared mind' mean? And how does this relate to nonlinear chemical dynamics?

SYNTHESIS

6. Why would it be hard to make new chemicals if all chemical reactions were oscillatory?

EVALUATION

7. Think about the last chemistry experiment you studied in school. Was that an example of a linear or nonlinear process? Why?

CREATIVITY

8. If you had to explain chaos to a non-scientist, how would you do this? Be creative! Many artists use chaos to inspire their work.

ACTIVITIES YOU CAN DO AT HOME OR IN THE CLASSROOM

MAKE YOUR OWN PH INDICATOR!

One of the ways oscillatory reactions are monitored is by using indicators – substances that change colour when the pH of the solution changes. Have a go at making your own red cabbage pH indicator! Full instructions can be found on the Carolina website:

<https://www.carolina.com/teacher-resources/Interactive/red-cabbage-guice-homemade-ph-indicator/tr10851.tr>

DEFINING NONLINEAR AND LINEAR PROCESSES

Take a tank or bowl of water and drop some ink or food colouring into it. Without moving the tank or bowl, watch how the ink/food colouring moves through the water. Note down your observations. Repeat the experiment, but this time stir the water in the tank or bowl. Do you think the mixing of the ink is a linear or nonlinear process?

MORE RESOURCES

Have a look at a video of Conway's Game of Life, a simulation that shows extreme nonlinear behaviour. You can even try coding your own!

<https://www.youtube.com/watch?v=Aq51GfPmD54>

Irv's lab also has videos of some of his experiments:

<http://hopf.chem.brandeis.edu>

(Click on Movies in the tabs at the top of the website.)