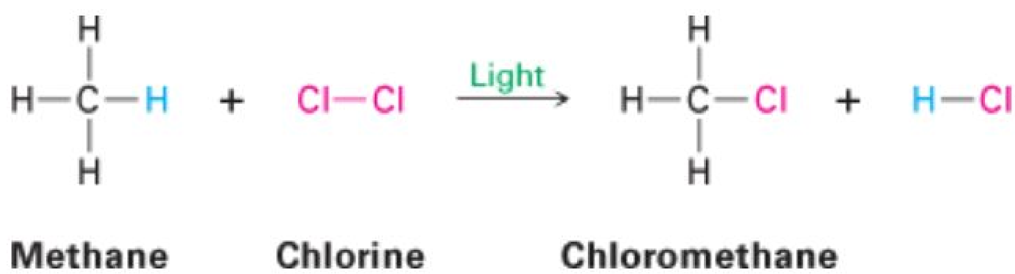
Student Name: ______________________________ Date: __________________

Activity Sheet

Radical Reactions

All chemical reactions, whether in the laboratory or in living organisms, follow certain order. To understand further, it's necessary to know *how* chemical reactions take place.

A mechanism describes what takes place at each stage of chemical transformation – which bonds are broken and which bonds are formed. Reaction mechanisms account for all reactants used and products formed. Radical reactions are symmetrical bond-breaking and bond-making processes. A radical is highly reactive because it contains an atom with an odd number of electrons in its valence shell, rather than a stable octet.



An example of an industrially useful radical reaction is the chlorination of methane to yield chloromethane. Methane chlorination requires three steps: *initiation, propagation*, and *termination*.

In this activity, students will look at the reaction mechanism of radical reactions and then, simulate a polymerization reaction by building polymers and determining their molecular weight. Moreover, students will discuss the impact of the conversion rate on radical reactions.

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Activity #1

Activating Prior Knowledge
Draw the mechanism for a homolytic radical reaction. Use curved arrows to indicate breaking and forming of bonds. Explain movement of electrons.

1. What are the 2 types of bond formation or breakage?

2. What is the difference between full head arrowheads and half head arrowheads (fish-hook)?

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Activity #2

Simulating a polymerization reaction.
Part A. Building a polymer.

Materials:

- K'Nex connectors and rods
- Die

Procedure:

1. Separate K'Nex connectors and rods in the bag.
2. Record color and mass of connectors and rod in table 1. There are only 3 distinct items and there is no need to obtain mass for all. Use a scale to determine the mass of connectors and rods.

Table 1

Color	Mass (g)

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3. Roll the die and record the action indicated by the roll in table 2.

Roll	Action
1, 4	**Initiation**
2, 5	**Propagation**
3, 6	**Termination**

Table 2

Polymer #1		Polymer #2	
Number	**Action**	**Number**	**Action**

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(Table 2 could be modified to allow additional rolls until both polymers are built).

4. Roll the die again to propagate your polymer.

Rules:

- A roll of 1 or 4 is necessary to start. Use a yellow connector to begin your polymer. Build your polymer from left to right.
- A roll of 2 or 5 is required to propagate your polymer. Upon rolling a 2 or a 5, a second roll determines the number of units to be added to your nascent polymer.
- If you are propagating your polymer and roll a “start” or “initiation,” record it on table 2 but do not initiate another polymer.
- Finish building one polymer before you proceed to the second polymer.
- While in the propagation step, continue rolling the die until your polymer is terminated. Use a yellow connector to terminate polymer.
- Only build linear polymers.

Each group is responsible for constructing several polymers. Polymers may be of same or different length.

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Part B. Determining the molecular weight of polymers.

Procedure:

1. Complete table 3 and table 4.
2. Record the color, mass and quantity of each of the connectors and rods used to build your polymers. Calculate the theoretical molecular weight of your polymers by multiplying mass and quantity and then adding totals.
3. Weigh each built polymer using the scale and record its weight in table 5. This will constitute the experimental molecular weight.

Table 3: Polymer#1

Color	Mass (g)	Quantity	Total
		Grand Total (Theoretical Molecular Weight)	

Table 4: Polymer#2

Color	Mass (g)	Quantity	Total
		Grand Total (Theoretical Molecular Weight)	

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Table 5

	Experimental Molecular Weight (g)
Polymer#1	
Polymer#2	

Compare the theoretical molecular weight and the experimental molecular weight for your polymers.

Is there a difference? How can you explain the difference on the molecular weight?

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Activity #3
Part C. Examining the conversion rate of reactions and the degree of polymerization.

Define conversion rate of reaction. Determine the molecular weight of your polymers when the conversion rate for the reaction is 50% and 25%. Use the theoretical molecular weight for your calculations. Explain your findings.

Research about the number average molecular weight, Mn and the weight average molecular weight, Mw in polymers. Discuss their differences.

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Assessment

Group work

Using the CER model, each group of students is responsible for selecting data from the activity and explaining a polymerization reaction on the template below.

Claim	
Evidence#1	
Evidence#2	
Reasoning#1	
Reasoning#2	

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Individually

Each student is responsible for a journal entry. Prompts are: *What I learned?* and *How I learned it*?

What did I learn?
How did I learn it? (A minimum of 4 sentences is required)

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Alternatively, students may write individual reflections.