

Click Chemistry: The Thiol-Alkene Reaction

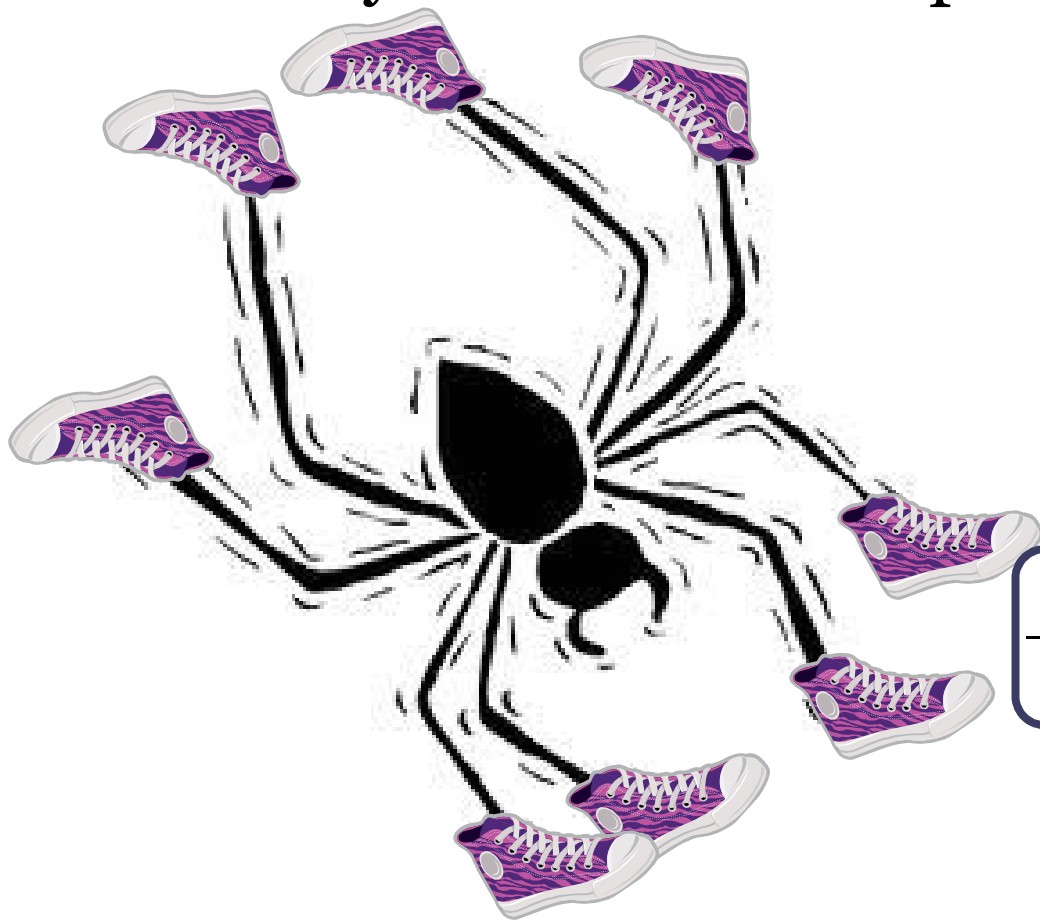
Chemistry so easy, even a physicist could do it!

-Charles Hoyle

2nd & 4th block
Chemistry

Stoichiometry Review

How many shoes would a spider need?



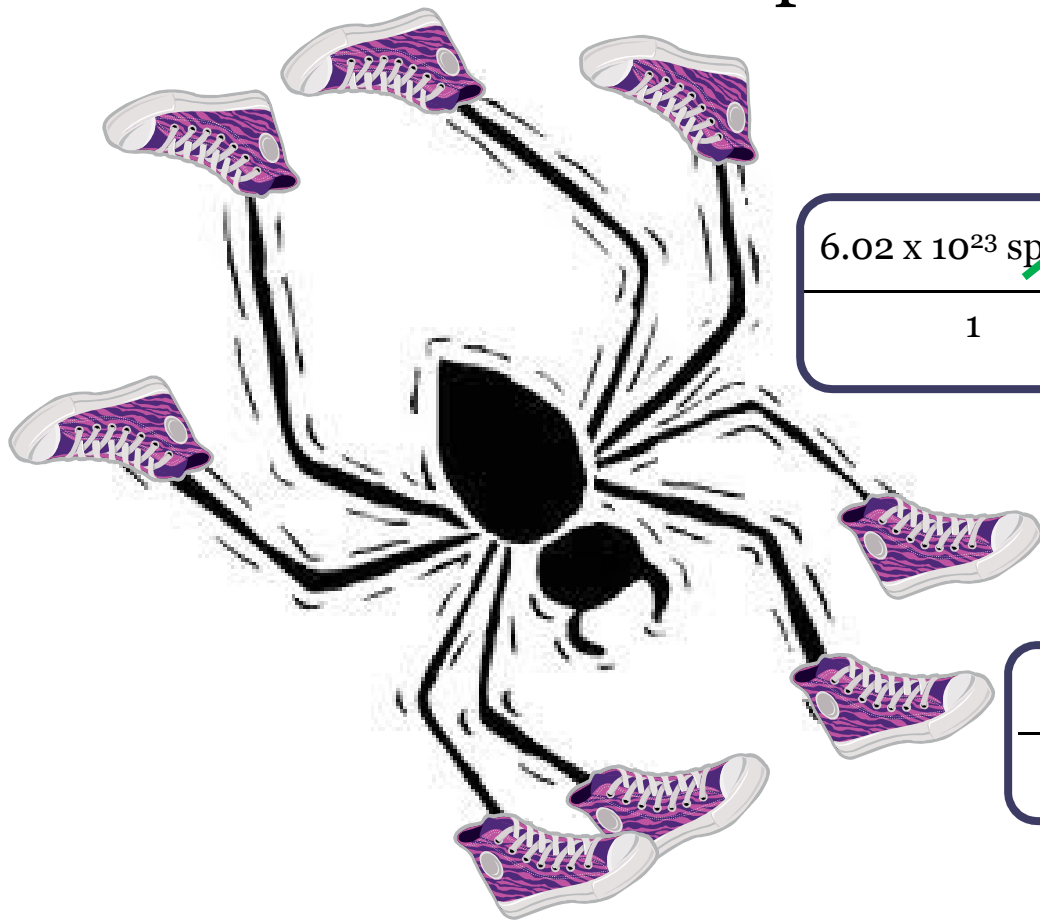
You automatically say 8, but here's the process that you're going through:

- 1 spider has 8 feet
- 1 foot fits into 1 shoe

1 spider	8 feet	1 shoe	= 8 shoes
1	1 spider	1 foot	

Stoichiometry Review

How about a mole of spiders?



- 6.02×10^{23} spiders
- 1 spider has 8 feet
- 1 foot fits into 1 shoe

6.02×10^{23} spiders	8 feet	1 shoe	= 4.8×10^{24} shoes
1	1 spider	1 foot	

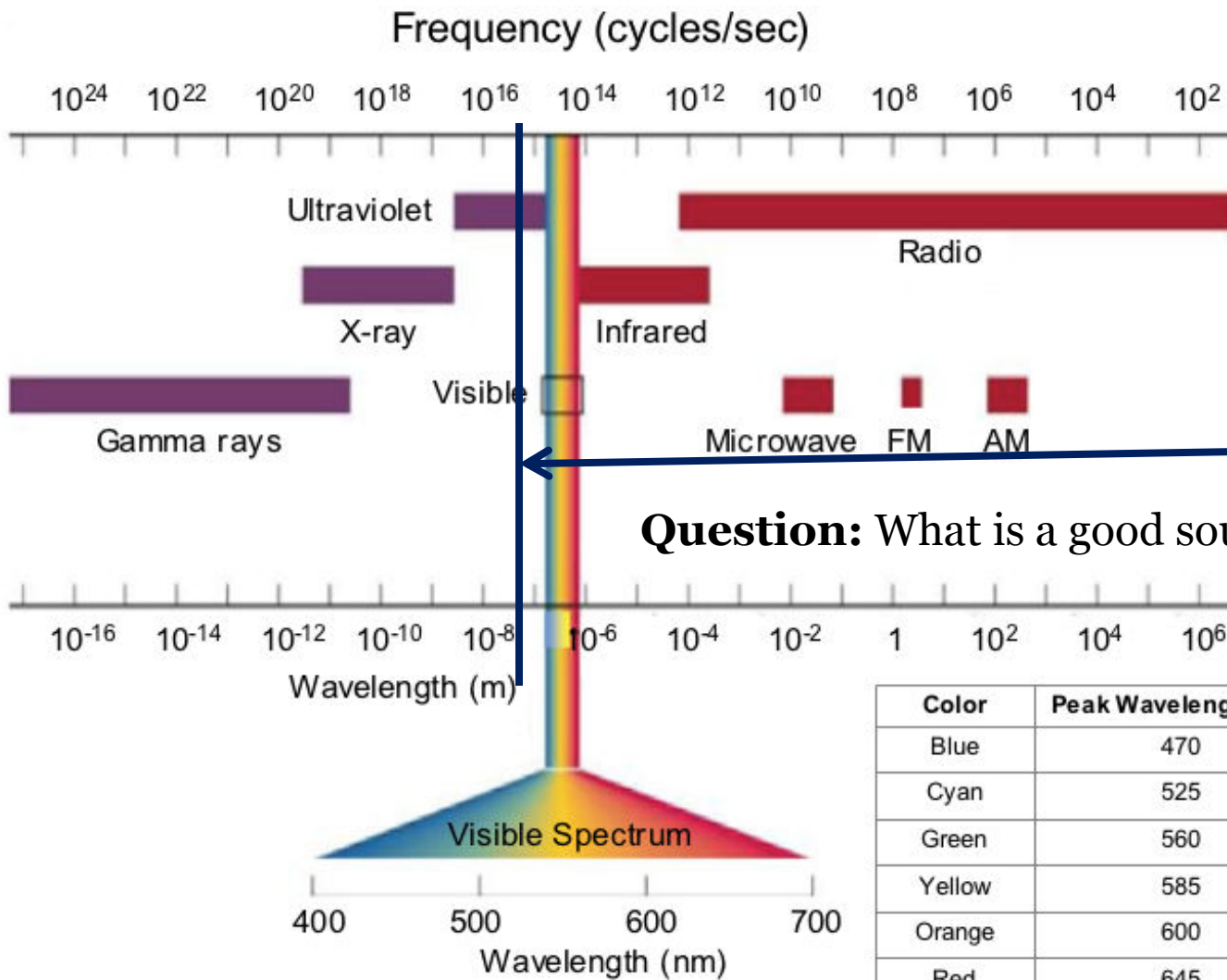
Compare this equation with the one that we used on Slide 2:

1 spider	8 feet	1 shoe	= 8 shoes
1	1 spider	1 foot	

Vocabulary

- **Thiol** – a molecule containing at least one **sulfur-hydrogen single bond**
 - Thiols give skunk spray its smell
- **Alkene** – a molecule containing at least one **carbon-carbon double bond**
- **Photoinitiator** – a molecule that **starts a reaction in the presence of light**
- **Functionality** – the number of **reacting groups in a molecule**

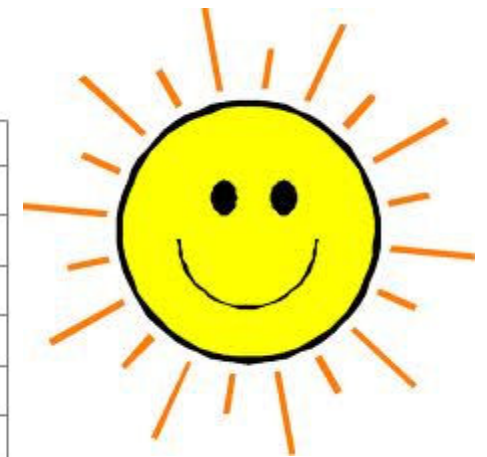
How the Photoinitiator Works



The PI is activated by light with a wavelength of 365 nm.

Question: What is a good source of ultraviolet light?

Color	Peak Wavelength [nm]
Blue	470
Cyan	525
Green	560
Yellow	585
Orange	600
Red	645
Deep Red	700



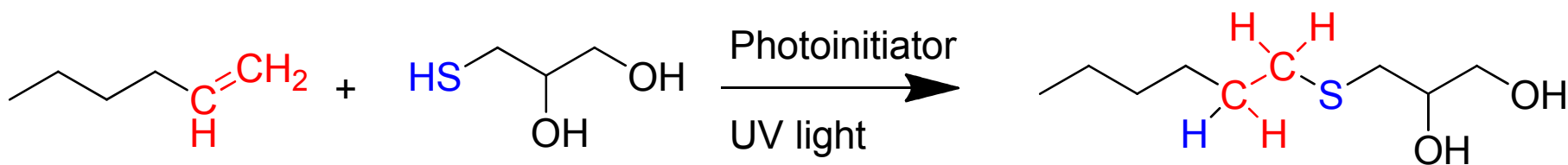
Click Reactions

- A click reaction must satisfy the following:
 - The reaction must be **fast**
 - The reaction must be **exothermic**
 - The reaction must result in a **high yield of the desired product**
 - The desired product must be **easily separated**
 - The reaction can be run at or near **ambient conditions**

Thiol-Alkene Stoichiometry

Let's consider a **monofunctional thiol** and a **monofunctional alkene**.

If we start with 10 g of **alkene**, how much **thiol** do we need for complete reaction?



1-hexene
84.16 g/mol

Thioglycerol
108.16 g/mol

The product is called a **thioether**.

Questions: Based on the product structure, how many thiols react with one alkene?
What are the functionalities of 1-hexene and thioglycerol?

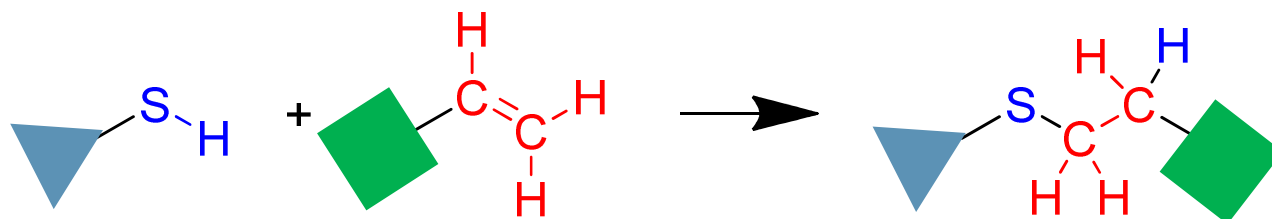
Thiol-Alkene Stoichiometry

Here's what we've just seen:

- 10 g **alkene**
- 84.16 g **alkene** = 1 mol **alkene**
- 1 mol **alkene** = 1 mol **C=C bonds**
- 1 mol **C=C bonds** = 1 mol **S-H bonds**
- 1 mol **S-H bonds** = 1 mol **thiol**
- 1 mol **thiol** = 108.16 g **thiol**

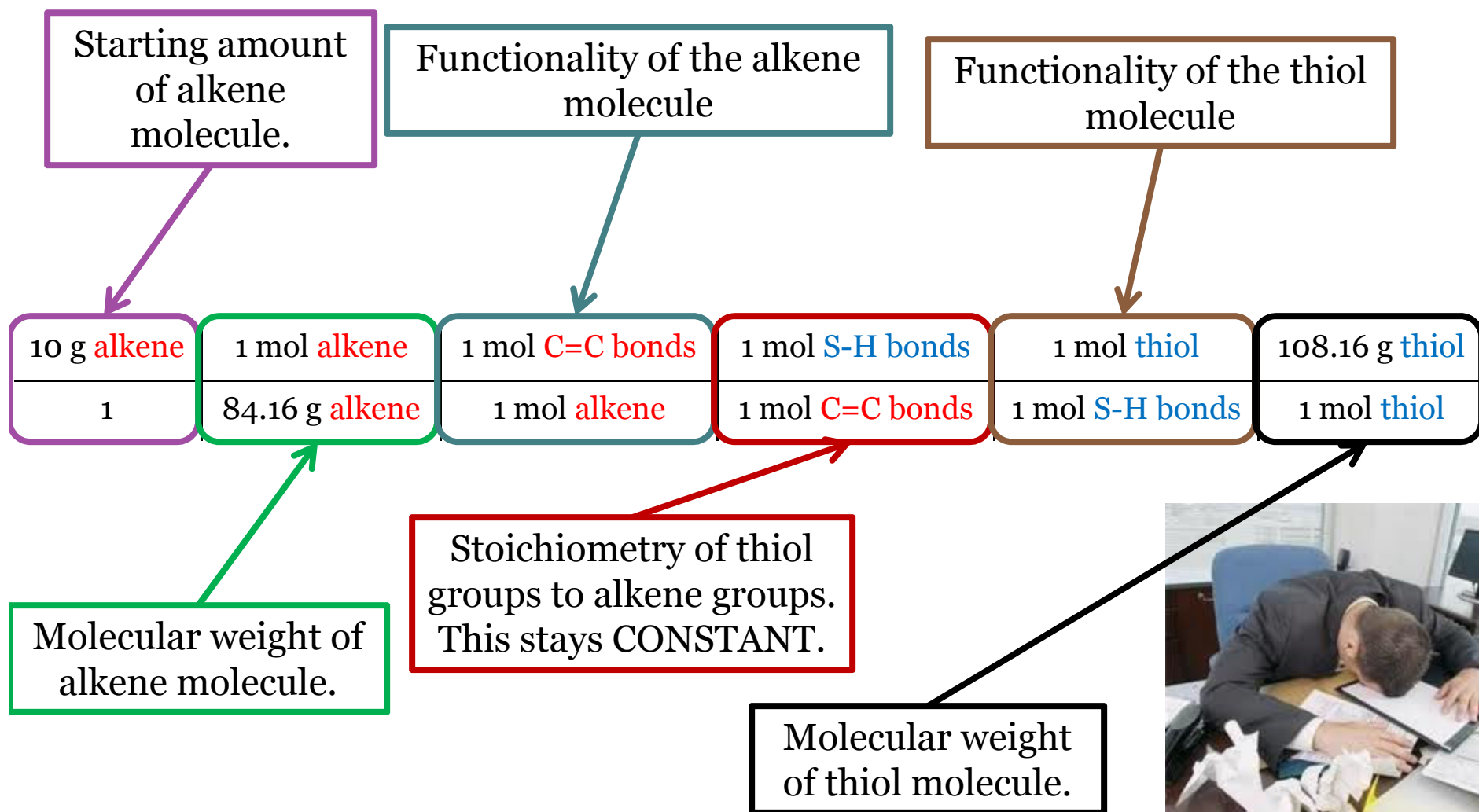
These conversion factors are important, even though it's just a whole bunch of ones.

10 g alkene	1 mol alkene	1 mol C=C bonds	1 mol S-H bonds	1 mol thiol	108.16 g thiol
1	84.16 g alkene	1 mol alkene	1 mol C=C bonds	1 mol S-H bonds	1 mol thiol



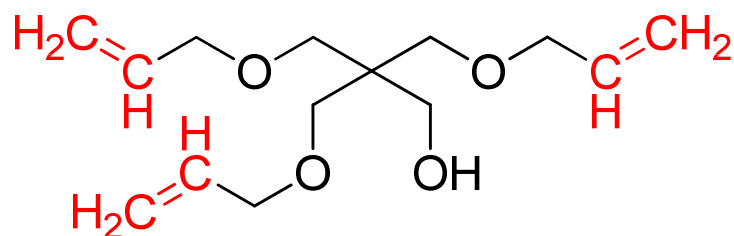
12.85 g thiol

A Closer Look at the Equation



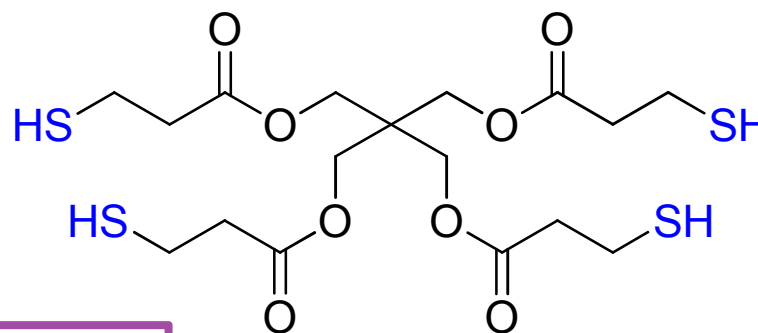
Lab: The Thiol-Alkene Reaction

Let's use a **trifunctional alkene** and a **tetrafunctional thiol**. Start with 10 g of trifunctional **alkene**. How much **thiol** do we need?



256 g/mol

14.3 g tetrathiol



489 g/mol

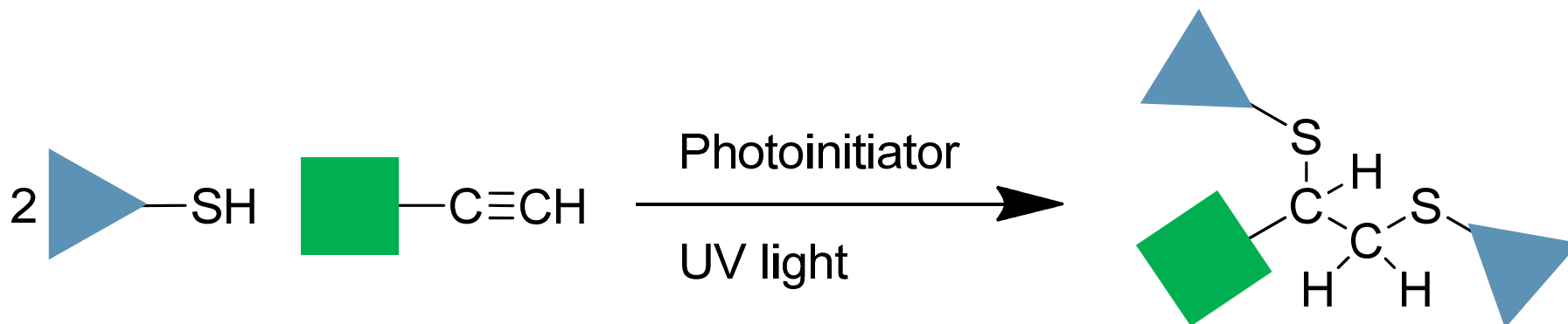
- 10 g **trialkene**
- 256 g **trialkene** = 1 mol **trialkene**
- 1 mol **trialkene** = 3 mol **C=C bonds**

- 1 mol **C=C bonds** = 1 mol **S-H bonds**
- 4 mol **S-H bonds** = 1 mol **tetrathiol**
- 1 mol **tetrathiol** = 489 g

10 g trialkene	1 mol trialkene	3 mol C=C bonds	1 mol S-H bonds	1 mol tetrathiol	489 g tetrathiol
1	256 g trialkene	1 mol trialkene	1 mol C=C bonds	4 mol S-H bonds	1 mol tetrathiol

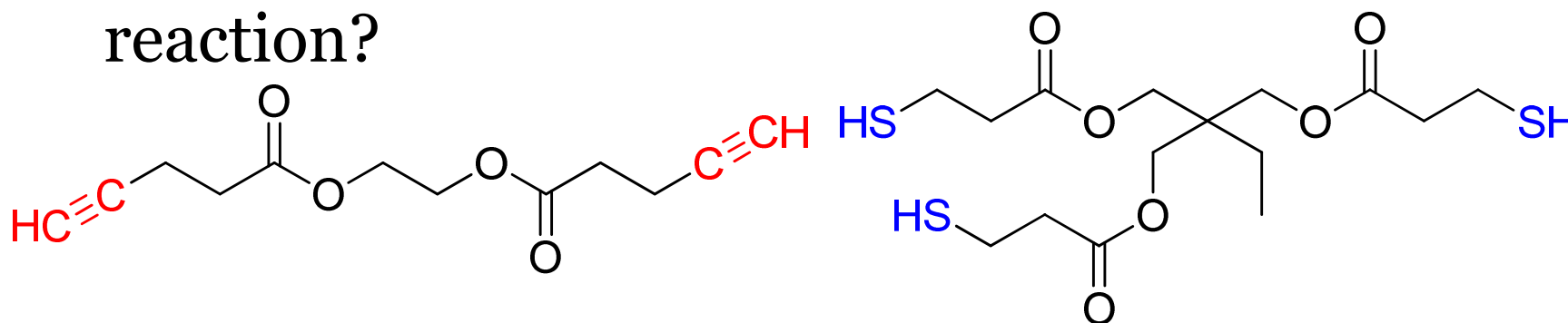
Thiol-Alkyne Reaction (Mr. J's research)

- **Alkyne** – any molecule with at least one **carbon-carbon triple bond**
- The thiol-alkyne reaction has stoichiometry of **2:1 thiol:alkyne**
- The product is called a **1,2-dithioether**



Thiol-Alkyne Reaction

- Given 10 g of a **difunctional alkyne** (222 g/mol), how much **trifunctional thiol** (399 g/mol) would be needed for a complete reaction?



10 g dialkyne	1 mol dialkyne	2 mol CC bonds	2 mol S-H bonds	1 mol trithiol	399 g trithiol
1	222 g dialkyne	1 mol dialkyne	1 mol CC bonds	3 mol S-H bonds	1 mol trithiol

24.0 g trithiol

Questions?

- Questions?
- Comments?
- Complaints?
- Desire to shout obscenities at the concept of stoichiometry?
- Tirades?
- Urges to throw something at Mr. Jungman?
- Riots?
- General consideration over the inwardly-contemplative-yet-outwardly-emotive state of mind?
- Praise?