

SI Organic Chemistry - Full Discipline Demo

Green Chemistry and Le Châtelier's Principle

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Organic Chemistry - Full Discipline Demo
Course	SI Organic Chemistry - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

Chemical equilibrium	State that occurs when the concentrations of all reactants and products are constant.	1
Chemical system	Determines if the reaction favors the products or the reactants	2
Equilibrium constant	In response to change, a chemical system will adjust in order to return to equilibrium.	3
Le Châtelier's principle	The reactants, products, and energy associated with a chemical reaction.	4

Correct answers:

- 1 Chemical equilibrium 2 Equilibrium constant 3 Le Châtelier's principle
4 Chemical system

Identify the variables that shift the equilibrium of a chemical reaction.

	Variables that would shift the equilibrium	Variables that would not shift the equilibrium
⌘ Concentration ⌘ Pressure ⌘ Size ⌘ Temperature ⌘ Molecular weight	1	2

Correct answers:

1 Concentration Pressure Temperature

2 Size Molecular weight

Classify the following as aspects of green chemistry or traditional chemistry.

Green Chemistry	Traditional Chemistry
1	2

⌘ Inherently safer chemistry for accident prevention

⌘ The use of petroleum based chemical feedstocks

⌘ The use of organic protecting groups in chemical synthesis

⌘ Design of biodegradable chemicals

⌘ The use of catalysts in organic synthesis

⌘ Use of temperatures near the solvent's boiling point

Correct answers:

1 The use of catalysts in organic synthesis

Design of biodegradable chemicals

Inherently safer chemistry for accident prevention

2 Use of temperatures near the solvent's boiling point

The use of organic protecting groups in chemical synthesis

The use of petroleum based chemical feedstocks

Exploration

Green chemistry aims to decrease _____ in the fields of chemistry and engineering.

- ☐ cost
- ☒ environmental impact
- ☐ pressure
- ☐ All of the above



Chemical equilibrium occurs when the concentration of ____.

- ☐ all reactants and all products remains constant
- ☐ reactants has reached zero
- ☐ products is greater than the concentration of reactants
- ☐ products and reactants is the same

✓

Chemical equilibrium occurs when the forward reaction rate is faster than the reverse reaction rate.

- ☐ True
- ☐ False

✓

If the value of K is greater than 1, the reaction favors the product.

- ☐ True
- ☐ False

✓

The equilibrium constant of a reaction requires the variables of ____, ____, and ____ to remain constant.

- ☐ color, pressure, concentration
- ☐ pressure, temperature, concentration
- ☐ concentration, time, temperature
- ☐ None of the above

✓

Le Châtelier's principle states that in response to change, a chemical system will adjust in order to return to equilibrium.

- ☐ True
- ☐ False

✓

The starch-iodide equilibrium can be shifted by changes in ____.

- ☐ pH
- ☐ pressure
- ☒ temperature
- ☐ None of the above

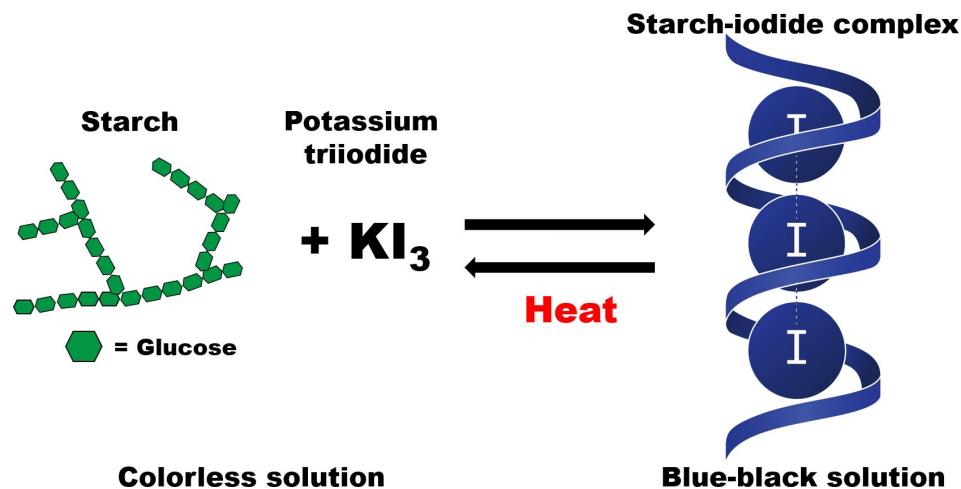


Exercise 1

**What did you manipulate in order to perturb the equilibrium of the starch-iodide complex?
Based on your results, how did you know the equilibrium had been altered?**

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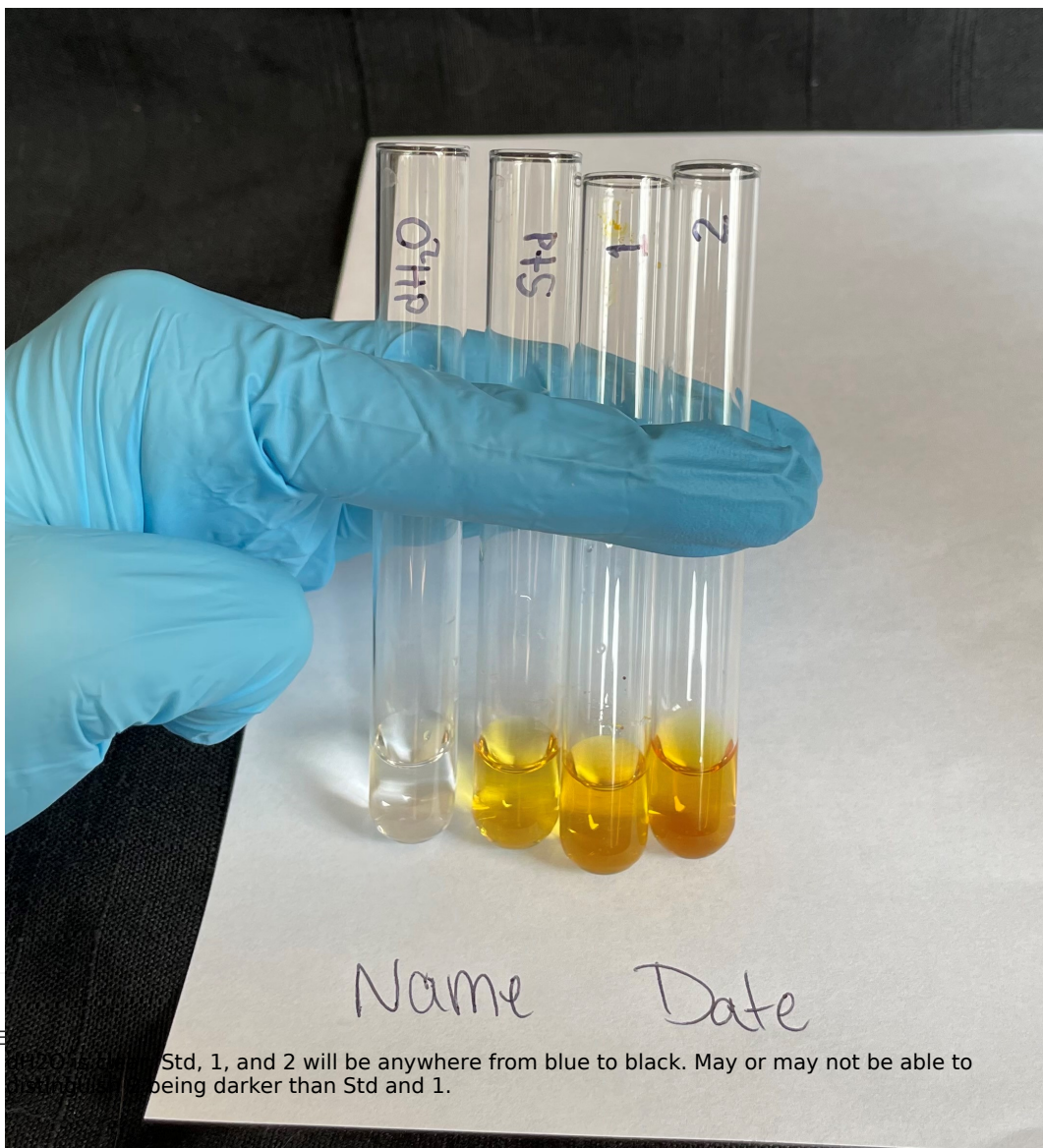
Based on the reaction below, which direction would the following changes to the reaction system shift the equilibrium?



- a) Increase the concentration of starch.
- b) Decrease the temperature of the system
- c) Increase the pressure of the system.
- d) Remove the potassium triiodide from the solution.

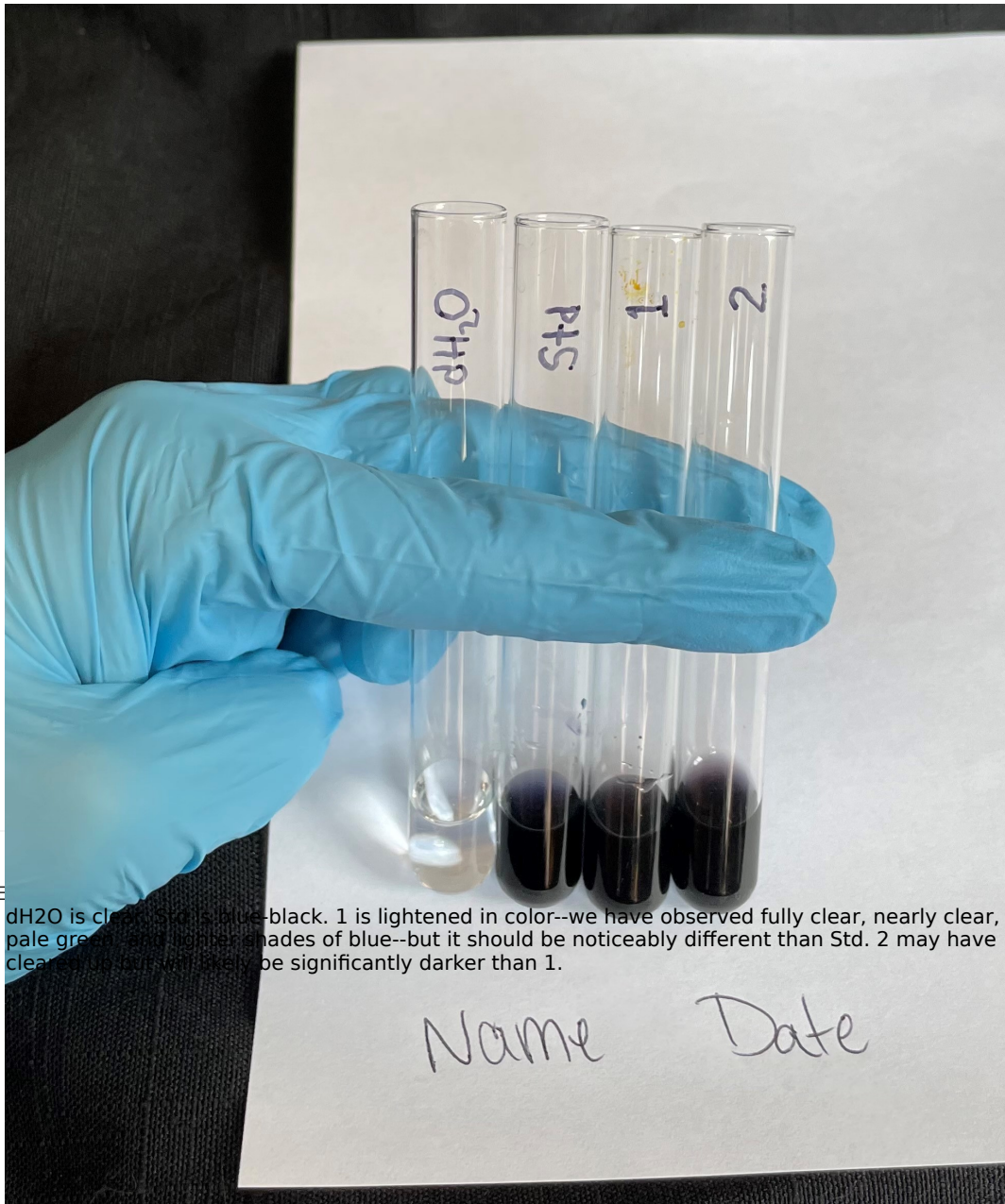
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Photo 1: Test tubes before starch addition
(SAMPLE ANSWER BELOW)
dH₂O is clear, Std & 1 are the same color (anywhere from yellow to brown, but not yet blue-black), 2 is nearly the same color but likely slightly darker



(SAMPLE

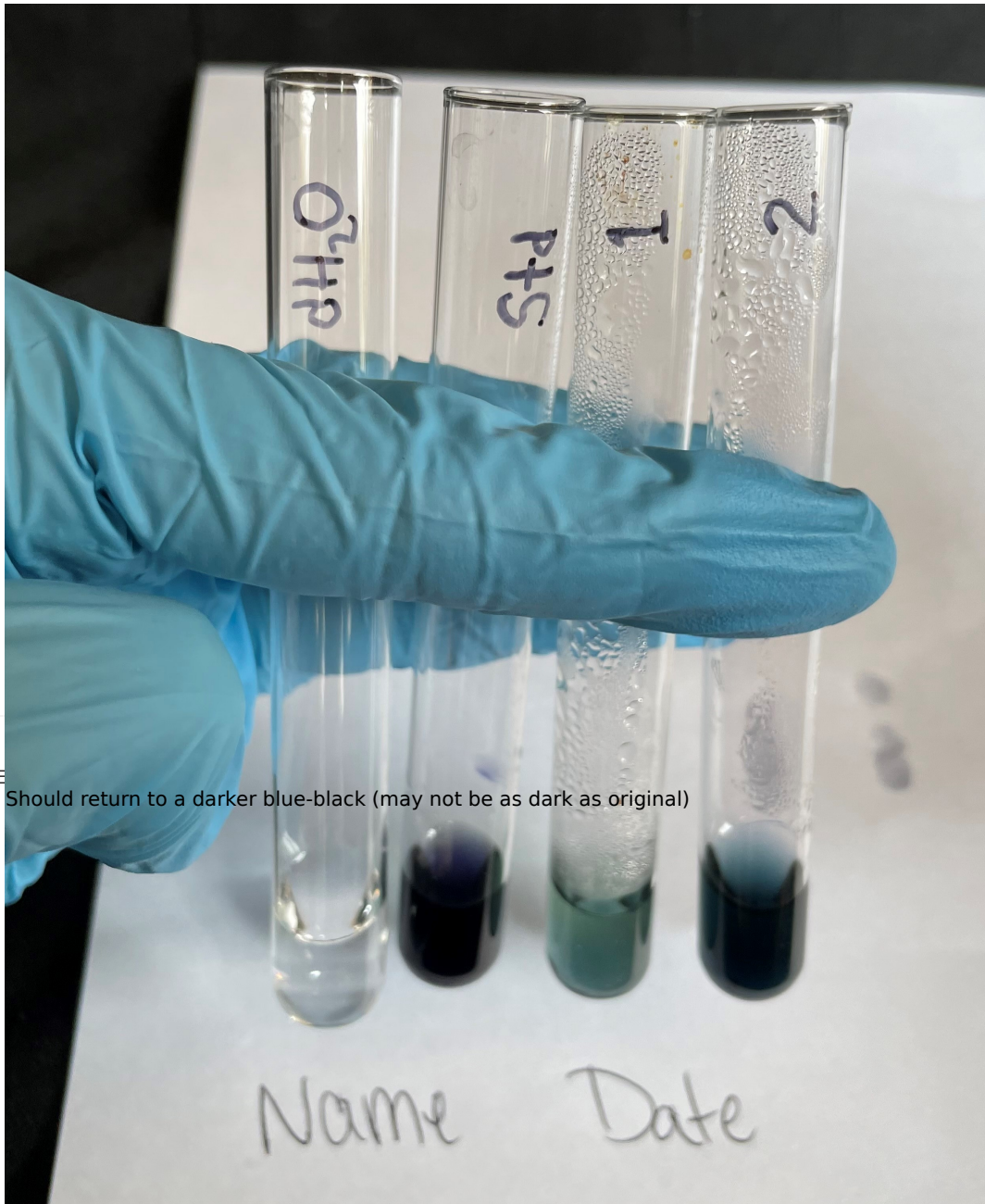
Std, 1, and 2 will be anywhere from blue to black. May or may not be able to
being darker than Std and 1.



(SAMPLE

dH₂O is clear. Std is blue-black. 1 is lightened in color--we have observed fully clear, nearly clear, pale green, and lighter shades of blue--but it should be noticeably different than Std. 2 may have cleared up but will likely be significantly darker than 1.

Name Date



(SAMPLE Should return to a darker blue-black (may not be as dark as original))



Exerc

What colors are the various forms of polyphenols when they are protonated vs deprotonated?

Proton

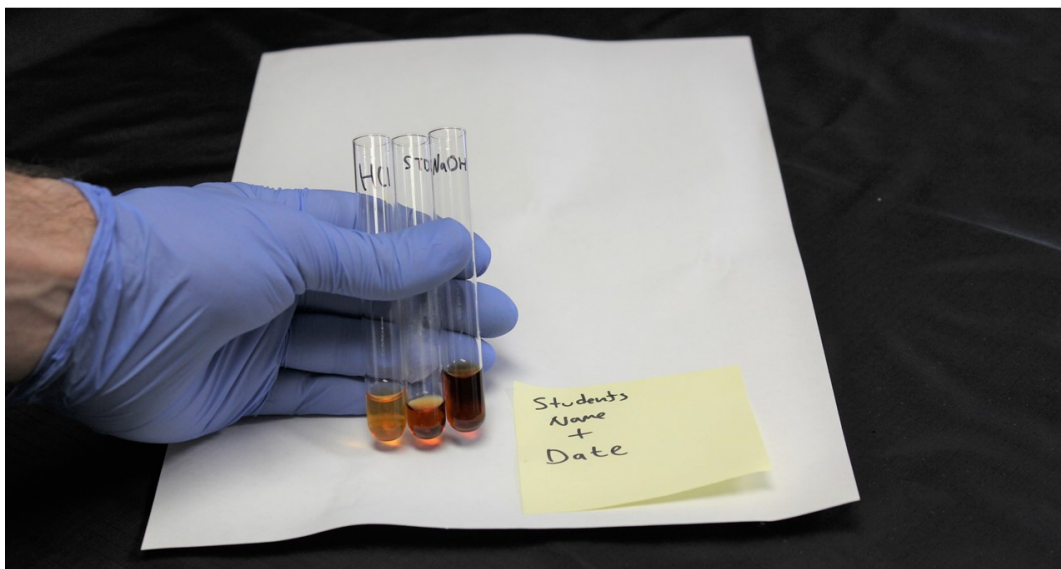
How does the equilibrium shift when HCl is added to the equilibrium reaction?

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Chemically speaking, what causes the color change when sodium hydroxide (NaOH) is added to the system?

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Photo 5: Addition of NaOH and HCl to Tea
(SAMPLE ANSWER BELOW)



Panel 1: Observations of hydrochloric acid effects on tea extract
(SAMPLE ANSWER BELOW)

The decrease in pH (addition of HCl) caused the color of the tea extract solution become lighter almost yellow.

Panel 2: Observation of the effects of sodium hydroxide on tea extract
(SAMPLE ANSWER BELOW)

The increase in pH (addition of NaOH) causes the color of the tea extract solution to become darker in color (brown)

Competency Review

A chemical system is in equilibrium when the concentrations of both reactants and products are constantly changing.

☐ True

☒ False

✓

The equilibrium constant of a reaction requires _____ to remain unchanged.

☒ pressure, temperature, and concentration

☐ temperature and concentration

☐ pressure, temperature, and time

☐ None of the above.

✓

According to Le Châtelier's Principle, an increase in the concentration of product will shift the chemical system to ____.

- ☐ the right (forward)
- ☒ the left (reverse)
- ☐ no shift
- ☐ None of the above.

✓

Le Châtelier's Principle states that when a change is imposed on a chemical system, the chemical system will adjust in order to return to equilibrium.

- ☒ True
- ☐ False

✓

A change in pH of a tea extract solution results in a ____, indicating a shift in chemical equilibrium.

- ☐ change in the state of matter
- ☒ color change
- ☐ temperature change
- ☐ None of the above

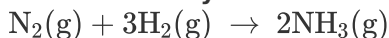
✓

When heating the starch-iodide solution to a temperature above 80°C, the observed color change from ____ indicates a shift towards ____.

- ☐ clear to blue; a bound starch-iodide complex
- ☐ blue to clear; a bound starch-iodide complex
- ☐ clear to blue; a dissociated starch-iodide complex
- ☒ None of the above

✓

In the reaction below, a decrease in the product NH_3 will result in ____ of the chemical system.



- ☐ a shift to the left
- ☒ a shift to the right
- ☐ no shift
- ☐ None of the Above

✓

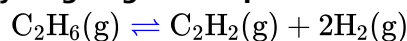
_____ is a principle of Green Chemistry.

- ☐ Inherently safer chemicals for accident prevention
- ☐ The use of catalysts
- ☐ Less hazardous chemical synthesis
- ☒ All of the above.

✓

Extension Questions

You are in charge of designing a process to produce acetylene (C_2H_2) from ethane (C_2H_6), which also produces hydrogen gas as a product.



$$\Delta H = \text{—}$$

The concentrations of the reactant and products along with the pressure, temperature, and volume of the chemical system can be adjusted for this process.

Apply your knowledge of equilibrium to suggest the set of conditions that will maximize the concentration of acetylene (C_2H_2) at equilibrium.

(SAMPLE ANSWER BELOW)

- Add ethane during the reaction to keep its concentration high
- Remove hydrogen during the reaction to keep its concentration low
- Run the reaction at a high temperature
- Run the reaction at low pressure