

SI Chemistry - Full Discipline Demo

Dissolved Oxygen

Final Report - Answer Guide

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

Test Your Knowledge

Match each term with the best description.

⚡ Biochemical O ₂ Demand	Nutrient enrichment of water negatively impacting the environment	1
⚡ Eutrophication	Oxygen-producing process	2
⚡ Hypoxic	Amount of dissolved oxygen consumed by bacteria to break down organic material	3
⚡ Photosynthesis	Oxygen deficient	4
⚡ Respiration	Oxygen-consuming process	5

Correct answers:

- 1 Eutrophication 2 Photosynthesis 3 Biochemical O₂ Demand
4 Hypoxic 5 Respiration

Determine if the following factors contribute to lower or higher dissolved oxygen concentrations.

⚡ Algal blooms	⚡ Daytime	⚡ High salinity	⚡ High summer temperatures
⚡ Low fall temperatures		⚡ Low salinity	⚡ Nighttime
⚡ Rapidly flowing water			

Low Dissolved Oxygen	High Dissolved Oxygen
1	2

Correct answers:

1 Algal blooms High summer temperatures High salinity Nighttime

2 Daytime Low salinity Low fall temperatures Rapidly flowing water

Order the steps of the Winkler Method from first to last.

≡	Iodine is oxidized by manganese(III) sulfate to release free iodine into the water sample
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1	Correct answer: Manganese(II) sulfate and potassium hydroxide solutions are added to the water sample
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≡	Addition of a strong acid to the water sample
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2	Correct answer: Addition of a strong acid to the water sample
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≡	Titration with sodium thiosulfate
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3	Correct answer: Iodine is oxidized by manganese(III) sulfate to release free iodine into the water sample
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≡	Manganese(II) sulfate and potassium hydroxide solutions are added to the water sample
---	---

4	Correct answer: Titration with sodium thiosulfate
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Exploration

Aquatic life require 2 mg/L of dissolved oxygen for healthy growth and activity.

- ☐ True
 - ☒ False
- ✓

_____ contribute(s) to the production of dissolved oxygen in aquatic environments.

- ☒ Photosynthesis
 - ☐ Respiration
 - ☐ Decomposition of dead animals or plants
 - ☐ Photosynthesis and respiration
- ✓

The amount of dissolved oxygen consumed by bacteria to break down organic material is known as _____.

- ☐ eutrophication
 - ☒ biochemical oxygen demand
 - ☐ hypoxia
 - ☐ solubility
- ✓

Eutrophication is caused by the introduction of _____ to the aquatic environment.

- ☐ oxygen
 - ☐ phosphates
 - ☐ nitrates
 - ☐ helium
 - ☒ phosphates and nitrates
- ✓
-

The maximum amount of oxygen that can dissolve into water is directly proportional to salinity and temperature.

☐ True

☐ False

✓

There tends to be more oxygen dissolved in a body of water during the ____.

☐ daylight hours

☐ nighttime hours

✓

During the Winkler Method, directly upon formation of the flocc, the manganese(II) oxidizes to form a ____ colored precipitate.

☐ purple

☐ pink

☐ brown

☐ black

✓

Exercise 1

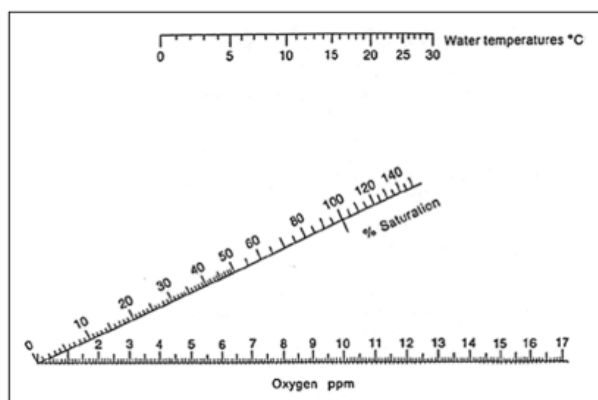
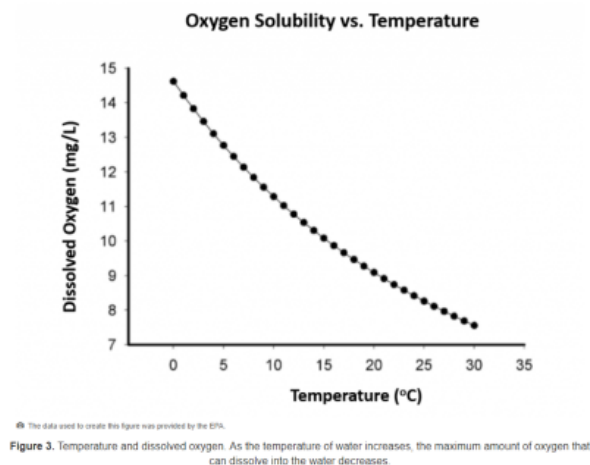
Which of the two water samples (hot or cold) contained the highest concentration of dissolved oxygen? Were your results what you expected? Explain your answer.

While the data will vary by student, all students should find that the cold water contained the highest concentration of dissolved oxygen. Cold water has a higher gas solubility than warm water due to gases having greater kinetic energy at increased temps and greater ability to "escape" the solution. Cold water has a higher gas solubility than warm water due to gases having greater kinetic energy at increased temps and greater ability to "escape" the solution. Cold water has a higher gas solubility than warm water due to gases having greater kinetic energy at increased temps and greater ability to "escape" the solution.

How saturated was the cold water sample? If it was not 100% saturated, explain possible reasons that it was not saturated to the full 100%.

The saturation of the cold water sample will vary by student. However, it is unlikely that their cold water sample will be 100% saturated. There are a variety of reasons that the cold water sample was not saturated to the full 100% including: Human error in reading the temperature, a change in temperature between the time the water sample was collected and the time that it was “fixed.” Air bubbles in the sample are a possible source of error, as are human errors in creating the sodium thiosulfate solution and titrating to just over the endpoint. There is also the possibility that the sample did not have ample time to reach maximum gas solubility at the lower temperature.

Review Figure 3. What would you expect the maximum dissolved oxygen concentration to be at 5°C? Explain how you reached this answer. Is the value you determined in Figure 3 the same or different than the value in Figure 11 (nomograph) at 5°C? If you determined two different values, explain possible reasons for the variation.



After reviewing Figure 3, the maximum dissolved oxygen concentration at 5°C would be approximately 12.75 mg/L. This answer was reached by going to the 5°C point on the temperature (horizontal) part of the chart and extending the point until it reached the curve, at approximately 12.75 mg/L. Using the nomograph in Figure 11, the dissolved oxygen concentration at 100% saturation is also approximately 12.75 mg/L. This means that both the data in Figure 3 and the nomograph in Figure 11 were created using similar salinity, pH, and pressure values.

Note: If a student is to find that the two values were different, they would have answered this question incorrectly.

Describe two of the processes that increase dissolved oxygen concentration in a body of water and two of the processes that decrease dissolved oxygen concentration in a body of water.

Two of the processes that increase the dissolved oxygen concentration in water include photosynthesis and water movement (flow rates). Two processes that decrease dissolved oxygen concentration in water are the addition of phosphates and bacteria, as well as large amounts of decaying matter and stagnant (non-moving) water.

Data Table 1: Dissolved Oxygen Data
(SAMPLE ANSWER BELOW)

Water Sample	Temperature (°C)	Initial Volume: Sodium Thiosulfate (mL)	Final Volume: Sodium Thiosulfate (mL)	Total Volume Added: Sodium Thiosulfate (mL)
Cold Water	Student answers will vary.	Student answers will vary.	Student answers will vary.	Student answers will vary.
Hot Water	Student answers will vary.	Student answers will vary.	Student answers will vary.	Student answers will vary.

Data Table 2: Dissolved Oxygen Concentration
(SAMPLE ANSWER BELOW)

Water Sample	Temperature (°C)	Dissolved Oxygen Concentration (mg/L = ppm)	Oxygen Saturation (%)
Cold Water	Student answers will vary.	Student answers will vary.	Student answers will vary.
Hot Water	Student answers will vary.	Student answers will vary.	

Competency Review

Dissolved oxygen levels of 2 mg/L in an aquatic environment is considered

_____.

- ☐ normal
- ☐ hyperoxic
- ☒ hypoxic



_____ is an oxygen-consuming process, whereas _____ is an oxygen-producing process.

- ☐ Photosynthesis; respiration
- ☒ Respiration; photosynthesis ✓
- ☐ Photosynthesis; decomposition of plants and animals

Algal blooms cause _____.

- ☐ algae to live a longer amount of time
- ☐ a decrease in decaying material
- ☐ a decrease in biological demand
- ☐ an overproduction of photosynthesis
- ☒ None of the above ✓
- ☐ All of the above

Eutrophication of waterways is caused by large quantities of nutrients from _____ entering the water.

- ☐ runoff from construction
- ☐ detergents and soaps
- ☐ sewage and fertilizers
- ☐ runoff, sewage, and fertilizers
- ☒ All of the above ✓

Chemical and physical factors such as pH, pressure, salinity, and temperature can change the ability of the water to dissolve oxygen.

- ☒ True ✓
- ☐ False

As temperature increases, the solubility of oxygen ____.

- ☐ increases
- ☒ decreases
- ☐ does not change

✓

In the Winkler Method, a ____ is added to the water sample to convert manganese(II) hydroxide to manganese(II) sulfate.

- ☒ strong acid
- ☐ weak acid
- ☐ strong base
- ☐ weak base

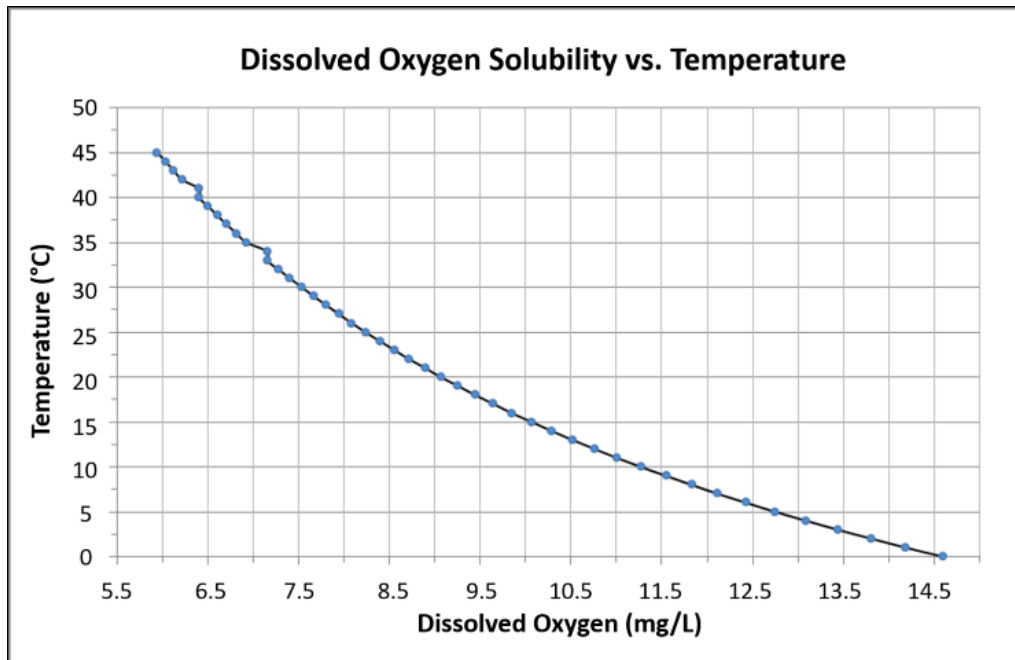
✓

During the final step of the Winkler Method, the conversion of the iodine to sodium iodide results in a color change from ____ to ____.

- ☐ colorless; yellow-brown
- ☐ red-yellow; brown
- ☒ yellow-brown; colorless
- ☐ colorless; red-yellow

✓

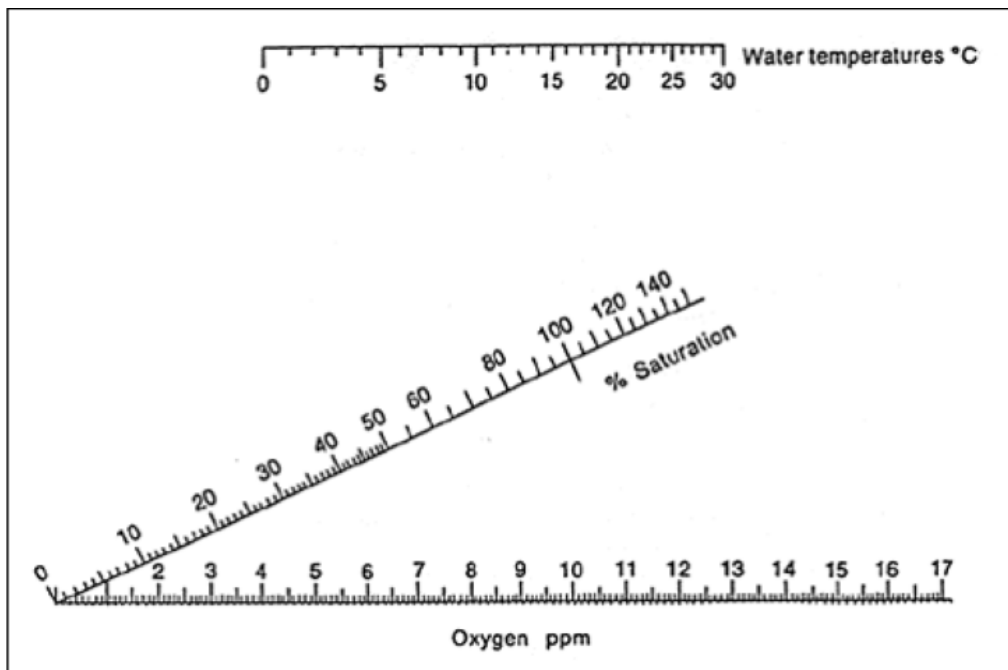
According to the graph below, what would be the maximum dissolved oxygen concentration at 25°C.



- ☐ 7.75 mg/L
- ☐ 9.5 mg/L
- ☐ 6.5 mg/L
- ☒ 8.25 mg/L



According to the nomograph below, ____ is the percent oxygen saturation for a temperature of 20°C and a dissolved oxygen concentration of 7 mg/L.



- ☐ 85%
- ☒ 75%
- ☐ 60%
- ☐ 90%

✓

Extension Questions

When oil spills occur in a body of water, scientists are very concerned about the formation of a "dead zone." Using the background as a starting point, describe how determining the dissolved oxygen content is crucial to determining the severity of an oil spill. Explain your answer. (SAMPLE ANSWER BELOW)

When oil spills occur in a body of water there is often a steep decrease in the levels of dissolved oxygen in the water. The oil covers the top of the water, prohibiting photosynthesis and in turn, lowering the amount of dissolved oxygen in the water. Likewise, the chemicals and microbes added to the water to break up the oil also impact the ecological health of the body of water. If the dissolved oxygen content drops below the minimum levels required to sustain the marine life (fish, plants, etc.), a "dead zone" will form.