NOAA Teacher at Sea Program
Lesson Plan Template

Activity Title: Interpreting Changes in Temperature, Salinity, and Density in a 24-Hour Period.

Subject (Focus/Topic): Properties of Seawater.

Grade Level: High school - University

Average Learning Time: This lesson can be completed in one class period but should be preceeded by a lecture on the topics of seawater temperature, salinity, and density and how these properties are measured.

Lesson Summary (Overview/Purpose): Students will use critical thinking skills to analyze and interpret data from a T-Chain, an instrument that measures rapid and precise changes in temperature, density, and salinity throughout the day.

Overall Concept (Big Idea/Essential Question): What is the impact of energy on properties of seawater?

Specific Concepts (Key Concepts): The effect of temperature on seawater; changes in seawater properties with depth.

Focus Questions (Specific Questions):

1. What relationships do you see between the 3 properties displayed on the plot (temperature, density and salinity?
2. Do the values change throughout the day? If so how? Make sure you discuss the various times of day beginning with 24:00 (midnight) and continue in 3 hour intervals for a 24-hour period (note that the graph displays time in 3 hour intervals – 12:00 is noon in the center of the graph).
3. What layer of the ocean does this plot display? (Depth is on the Y axis).
4. At what depth does this layer interact with the layer beneath it? What is the name of that layer of the ocean?
5. Which property changes the most throughout the day? Why?

Objectives/Learning Goals: Students will be able to:

- Identify the values for ocean temperature, salinity, and density at various depth and time intervals in the ocean based on the T-Chain graph provided.

- Compare and contrast the properties of seawater displayed on the T-Chain graph.

- Evaluate which property of seawater changes the most during the day and defend the answer with supporting data from the graph.

Background Information: Students may need some basic prepartion in the following:

- Reading and interpreting graphs.
- Interpreting the T-Chain graph axes so that students know which graph is salinity and which is density.
- Determining time using military time and the 24-clock.

Common Misconceptions/Preconceptions: N/A

Materials: The list of questions and the T-Chain plot. Teachers may want to review the Hams TAS blog discussing "All About CTDs". The blog provides an explanation of the T-Chain and why it is being used in the Indian Ocean. This particular instrument measures small changes in seawater properties throughout the day.

Technical Requirements: If a computer lab is available, students should view the T-Chain plot in high resolution on the computer. This also gives students the capability to enlarge the image.

Teacher Preparation: Review lectures on temperature, salinity, and density. Also review the Hams TAS blog (see Materials above) for detailed informationon the T-Chain.

Keywords: T-Chain plot, salinity, density

Pre-assessment Strategy/Anticipatory Set (Optional): N/A

Lesson Procedure: The basic procedure is to prepare the students with a lecture on temperature, salinity and density and complete the activity. This activity can be used in a lecture or lab class.

Assessment and Evaluation: The students will be evaluated using the grading rubric below.

Grading Rubric

Relationship between Temperature (T), Density (D), & Salinity(S) compared and contrasted	Weak analysis; poor spelling and grammar.	Moderate analysis; good spelling and grammar.	Good analysis; no spelling or grammar errors.
T, D, & S values listed and contrasted for the following time intervals: 24:00, 03:00, 06:00, 09:00, 12;00, 15:00, 18:00, and 21:00	T, D, & S values accurately listed for a few time intervals.	T, D, & S values accurately listed for some time intervals.	All T, D, & S values accurately listed for all time intervals.
Take home question answered (Evaluate which property of seawater changes most during the day?) and supported with data from the T-Chain graph.	Take home question not answered in sufficient detail and not supported with sufficient data from the T-Chain graph. Poor spelling and grammar.	Take home question answered in sufficient detail and supported with data from the T-Chain graph. Good spelling and grammar.	Take home question answered in good detail and supported with data from the T-Chain graph. No spelling or grammar errors.

Standards:

- **National Science Education Standard(s) Addressed:**

  Science as Inquiry
  Physical Sciences
  Science in Personal and Social Perspectives – specifically
  - Natural & human-induced hazards
  - Science & technology in local, national, & global challenges

- **Ocean Literacy Principles Addressed:**
  - The Ocean is a major influence on weather and climate
  - The ocean supports a great diversity of life and ecosystems
  - The ocean and humans are inextricably interconnected
  - The ocean is largely unexplored

- **State Science Standard(s) Addressed:** California Earth Scinces standards for Grades 9-12:

  - Energy In the Earth's System
    - Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms.

  - Investigation and Experimentation

- Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

- **Other National or State Standards Addressed (Optional)** N/A

Additional Resources: N/A

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