Unit 5: Meteorology

Content Area: **Science**
Course(s):
Time Period: **Marking Period 1**
Length: **4 Weeks**
Status: **Published**

Brief Summary of Unit

Building upon prior foundational knowledge of marine thermal capacity and circulation, students will investigate the atmospheric mechanics driving Earth's weather systems and climate phenomena. This unit analyzes the thermodynamic and physical principles governing air mass interactions, atmospheric pressure gradients, water phase changes, and global wind belts influenced by the Coriolis effect. Students will examine ocean-atmosphere interactions—such as latent heat transfer, sea surface temperature anomalies, and feedback loops like El Niño-Southern Oscillation (ENSO)—to evaluate how marine energy fuels severe meteorological hazards (e.g., tropical cyclones and frontal storms). Ultimately, students will utilize synoptic weather data and modeling tools to forecast atmospheric behavior and evaluate climate-driven impacts on human infrastructure and safety.

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Standards

P.1	Act as a responsible and contributing community members and employee.
L.SS.11–12.1	Demonstrate command of the system and structure of the English language when writing or speaking.
P.3	Consider the environmental, social and economic impacts of decisions.
P.4	Demonstrate creativity and innovation.
P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
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L.KL.11–12.2	Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.
4	Model with mathematics Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it

	has not served its purpose.
P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
5	Use appropriate tools strategically
P.9	Work productively in teams while using cultural/global competence.
	Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.
HS-PS2-1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
W.AW.11–12.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Essential Questions / Enduring Understandings

Essential Questions

1. How do thermal energy transfer, fluid dynamics, and phase changes of water interact to drive atmospheric circulation and power daily weather systems?

2. In what ways do coupled ocean-atmosphere feedback loops (such as ENSO and latent heat flux) amplify, regulate, and fuel severe meteorological hazards?
3. How can meteorologists utilize synoptic data and predictive modeling to forecast weather behavior, and how do these tools inform engineering solutions to protect human infrastructure and public safety?

Enduring Understandings

1. Earth's weather is driven by an atmospheric thermodynamic heat engine, where solar energy imbalances, atmospheric pressure gradients, phase changes of water, and the Coriolis effect continuously work to redistribute heat globally across air masses and planetary wind belts.
2. The ocean and atmosphere operate as a tightly linked system, in which vast quantities of stored oceanic heat and moisture are transferred to the atmosphere, fueling extreme events like tropical cyclones and shifting global climate anomalies over short and long timescales.
3. Accurate weather forecasting relies on fluid mechanics models and real-time synoptic data, giving societies the ability to anticipate atmospheric behavior, mitigate severe weather risks, and design resilient infrastructure.

Assessment

Formative:

Do Now Questions

Exit Ticket Questions

Whole Class Discussion Participation

Small Group Discussion Participation

Individual Student Questions/Responses

Independent Tasks

Lab Experiments

Quizzes

Summative:

Lab Report

Unit Test

Benchmark:

Midterm/Final Exam

Alternative Assessments:

Guided Formal Lab Report

Unit Study Guide

Objectives : Students will know/ Students will be skilled at

- • Compare the volume of a gas under varying pressure and temperature.
- • Demonstrate how fluids exert an upward force on objects immersed in them: buoyant force.
- • Determine how Earth's rotation of Earth, pressure, and temperature differences create wind.
- • Determine how solar energy is distributed throughout the atmosphere.
- • Determine how the density of gases changes with pressure and/or temperature.
- • Determine the factors involved in cloud formation.
- • Distinguish the different properties in air masses and how they form weather conditions.
- • Explain why the volume of a gas is (under normal atmospheric conditions) independent of its composition.
- • How the gas laws are related to weather and the atmospheric processes.
- • Identify factors that cause water to continuously move through the water cycle.
- • Identify factors that determine global weather patterns.
- • Identify the quantitative composition of the atmosphere.

Learning Plan

- • Activity/Assessment – Hollywood Science project (Twister, Day After Tomorrow)
- • Compare and contrast a high pressure system and a low pressure system.
- • Compare and contrast humidity and relative humidity.
- • Describe how the atmosphere has evolved over time.
- • Describe the formation of fronts.
- • Describe the importance of water vapor in the atmosphere.
- • Describe the process that causes a water droplet to fall to Earth as precipitation.
- • Describe various severe weather situations.
- • Differentiate the gases in the atmosphere.

- • Differentiate the main global wind systems.
- • Differentiate the various types of air masses and discuss how they form.
- • Discuss the relationship between temperature and altitude in a temperature inversion.
- • Discussion: Meteorology is the interdisciplinary scientific study of the atmosphere.
- • Distinguish between climate and weather.
- • Explain how atmospheric pressure changes with height in the atmosphere.
- • Explain how heat transfer plays a role in the formation of an air mass.
- • Explain how temperature and humidity are related.
- • Explain how the dew point is related to saturation.
- • Explain how the jet stream affects the movement of air masses.
- • Identify the primary layers of the atmosphere.
- • Identify various cloud types by their appearance and the altitudes at which they typically occur.
- • Introduce the ozone layer and discuss its importance.
- • Lab/Activity – Air Pressure
- • Lab/Activity – Condensation and why cold surfaces become wet
- • Lab/Activity – Gas laws and three methods of energy transfer
- • Lab/Activity – Identifying clouds
- • Lab/Activity – Reading a barometer
- • Lab/Activity – Weather forecasting tools
- • Lab/Activity/Assessment – Illustrating the different layers of the atmosphere
- • Lab/Activity/Project – Weather forecasting and prediction presentation
- • Meaningful participation in guided question/answer sessions, individual/group discussions, demonstrating an understanding of the purpose of the unit lesson(s), key terms, and concepts
- • Preview the essential questions, provide answers, and connect to learning throughout the unit
- • Quiz/Assessment – Gas laws
- • Quiz/Assessment – Methods of energy transfer
- • Rank the main atmospheric gases in the troposphere from most to least abundant.
- • Unit Assessment

Materials

- Earth Science, Glencoe
- Earth Science, Merrill, and ancillary resource materials
- Earth Science, Prentice-Hall, and ancillary resource materials
- Meteorology, Merrill
- quantitative/qualitative lab equipment for activities, experiments
- related meteorological maps
- supplementary interactive multimedia, internet websites, videos
- Textbook, Physical Science with Earth Science, Glencoe, and ancillary resource materials

Accommodations and Modifications