

August 12, 2004

State Science Standards Relating to Waves

Investigations on Ocean Waves relate to concepts in physics, physical science, earth science, marine science, technology and mathematics. Physical Oceanographers are scientists who have specialized in understanding, observing, measuring, modeling, and predicting "motion in the ocean"--waves, currents, tides, winds. These, in turn reflect natural events, such as hurricanes, hazards to people. Waves provide access to inquiry and the nature of science.

The activities associated with waves align to national and state standards. Using data from Coastal Ocean Observing Systems, such as SEACOOS, provides relevant information for students to set up their studies and to investigate past events from archived data.

<i>North Carolina (Link)</i>	<i>Page 1</i>
<i>South Carolina (Link)</i>	<i>Page 4</i>
<i>Georgia (Link)</i>	<i>Page 8</i>
<i>Florida (Link)</i>	<i>Page 11</i>
<i>National Science Education Standards</i>	<i>Page 19</i>

1. North Carolina Science Curriculum Competencies (2005-2006)

6th Grade

Competency Goal 1: The learner will design and conduct investigations to demonstrate an understanding of scientific inquiry.

Objective 1.05 Analyze evidence to :

- Explain observations.
- Make inferences and Predictions.
- Develop the relationship between evidence and explanation.

Objective 1.06 Use mathematics to gather, organize, and present quantitative data resulting from scientific investigations:

- Measurement.
- Analysis of data.
- Graphing.
- Prediction models.

7th Grade

Competency Goal 1: The learner will design and conduct investigations to demonstrate an understanding of scientific inquiry.

Objective 1.05 Analyze evidence to :

- Explain observations.
- Make inferences and Predictions.
- Develop the relationship between evidence and explanation.

Objective 1.06 Use mathematics to gather, organize, and present quantitative data resulting from scientific investigations:

- Measurement.
- Analysis of data.
- Graphing.
- Prediction models.

Competency Goal 3: The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the atmosphere.

Objective 3.05 Examine evidence that atmospheric properties can be studied to predict atmospheric conditions and weather hazards:

- Humidity.
- Temperature.
- Wind speed and direction.
- Air pressure.
- Precipitation.
- Tornados.
- Hurricanes.
- Floods.
- Storms.

Objective 3.06 Assess the use of technology in studying atmospheric phenomena and weather hazards:

- Satellites.
- Weather maps.
- Predicting.
- Recording.
- Communicating information about conditions.

8th Grade

Competency Goal 1: The learner will design and conduct investigations to demonstrate an understanding of scientific inquiry.

Objective 1.05 Analyze evidence to :

- Explain observations.

- Make inferences and Predictions.
- Develop the relationship between evidence and explanation.

Objective 1.06 Use mathematics to gather, organize, and present quantitative data resulting from scientific investigations:

- Measurement.
- Analysis of data.
- Graphing.
- Prediction models.

Competency Goal 3: The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the hydrosphere.

Objective 3.06 Evaluate technologies and information systems used to monitor the hydrosphere.

Grades 9-12

Earth/Environmental Science

Competency Goal 1: The learner will develop abilities necessary to do and understand scientific inquiry in the earth and environmental sciences.

Objective 1.03 Evaluate the uses of satellite images and imaging techniques in the earth and environmental sciences.

Competency Goal 4: The learner will build an understanding of the hydrosphere and its interactions and influences on the lithosphere, the atmosphere, and environmental quality.

Objective 4.03 Analyze the mechanisms that produce the various types of shorelines and their resultant landforms:

- Nature of underlying geology.
- Long and short term sea-level history.
- Formation and breaking of waves on adjacent topography.
- Human impact.

Objective 4.05 Investigate and analyze environmental issues and solutions for North Carolina's river basins, wetlands, and tidal environments:

- Water quality.
- Shoreline changes.
- Habitat preservation.

Grades 9-12

Physical Science

Competency Goal 3: The learner will analyze energy and its conservation.

Objective 3.04 Investigate and analyze the transfer of energy by waves:

- General characteristics of waves: amplitude, frequency/period, wavelength, velocity of propagation.
- Mechanical waves.
- Sound waves.
- Electromagnetic waves (radiation).

Grades 9-12

Physics

Competency Goal 7: The learner will develop an understanding of wave motion and the wave nature of sound and light.

Objective 7.01 Analyze, investigate, and evaluate the relationship among the characteristics of waves:

Wavelength.

Frequency.

Period.

Amplitude.

Objective 7.02 Describe the behavior of waves in various media.

2. South Carolina Science Standards

5th grade:

III. Earth Science

Unit of Study: Changes in the Earth's Surface: Landforms and Oceans

A. Structure of the Earth System

1. Land forms are the result of a combination of constructive and destructive forces.

j. Infer how waves, currents, tides, and storms affect the geological features of the ocean shore zone (e.g., beaches, barrier islands, inlets, estuaries, and harbors, etc.)

IV. Physical Science

Units of Study: Mixtures and Solutions
Forces, Motion, and Design

B. Motions and Forces

2. If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another.

b. Investigate and describe how forces affect the motion of objects.

6th grade:

IV. Physical Science

Unit of Study: Physical Properties and Changes of Matter

A. Properties and Changes of Properties in Matter

1. A substance has characteristic properties, such as density, boiling point, and solubility, all of which are independent of the amount of the sample.

- a. Investigate the direct relationship between the amount of water an object displaces and the object's volume.
- b. Relate the properties of sinking and floating to different densities of substances (hydrometer).

Unit of Study: Machines and Work

B. Motion and Forces

- 1. If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.**
- e. Investigate how machines can reduce the effect of the forces of friction and gravity.

Unit of Study: Forms and Transfer of Energy

C. Energy is transferred in many ways.

- 1. Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, and the nature of a chemical.**
 - a. Identify sources of heat, light, sound, electrical and chemical energy, and mechanical motion.
 - b. Recognize and identify heat, light, sound, electrical and chemical energy, and mechanical motion as forms of energy.
- 2. Energy is transferred in many ways.**
 - a. Demonstrate how mechanical energy is transformed to another form of energy (e.g., vibrations, heat through friction).

8th grade:

IV. Physical Science

Unit of Study: Forces and Motion

A. Motions and Forces

- 1. The motion of an object can be described by its position, direction of motion, and speed and can be measured and represented on a graph.**
 - a. Operationally define speed, velocity, acceleration, and momentum and apply these in real world situations.
- 2. An object that is not being subjected to a force will continue to move at a constant speed in a straight line. If more than one force acts on an object along a straight line then the forces will reinforce or cancel one another depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.**

- a. Analyze the direction and effects of forces in a variety of situations (e.g., gravity and friction).
- b. Compare and contrast forces that are balanced and unbalanced.
- c. Use arrows to illustrate the magnitude and direction of a force applied to an object.
- d. Analyze the effect of an unbalanced force on an object's motion in terms of speed and direction.
- e. Analyze the effect of balanced forces on an object's motion in terms of speed and direction.
- f. Predict what happens to an object at rest or an object in motion when unbalanced forces act upon it.

9th-12th:

III. Earth Science

A. Energy in the Earth System

4. The hydrosphere is affected by both internal and external sources of energy. Solar energy drives the hydrologic cycle and produces convection in the hydrosphere. The outward transfer of Earth's internal heat drives hydrothermal processes. (Not an NSES Standard)
 - a. Describe how solar energy is transferred to ocean currents and waves.
 - b. Investigate and describe the formation of waves and the effects of the transfer of energy as waves interact with the shore.
 - c. Evaluate the effectiveness of human interventions designed to reduce the effects of rising sea level and waves on coastal erosion.

IV. Physical Science (CHEMISTRY)

B. Structure and Properties of Matter

- 1. Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.**

Compare and contrast solids, liquids, and gases in terms of particle arrangement and the energy that binds them together.

IV. Physical Science (PHYSICS)

A. Motions and Forces

B. Conservation of Energy and the Increase in Disorder

1. The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed. As these transfers occur, the matter involved becomes steadily less ordered.

a. Evaluate transformations between potential and kinetic energies and other forms of energy.

b. State and apply quantitative relationships between energy, work, power, and efficiency.

2. All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.

a. Classify energy types as potential, kinetic, or electromagnetic

C. Interactions of Energy and Matter

1. Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.

a. Identify and show relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength.

b. Compare and contrast models of longitudinal and transverse waves.

c. Give examples of the wave behaviors of reflection, refraction, diffraction, interference, polarization, and Doppler effect

c. Distinguish between the electromagnetic spectrum, seismic waves, water waves and sound waves based on their properties and behaviors.

d. Describe the energy of a wave in terms of amplitude and frequency.

3. Georgia State Science Standards for Grades 6-8

Grades 6-8

SCSm4. Students will be able to use the ideas of system, model, change, and scale in exploring scientific and technological matters.

1SCSm4.a Observe and explain how parts are related to other parts in systems such as cars, computers, and creatures, including how the output from one part of a system (in the form of material, energy, or information) can become the input to other parts.

Grade 8 Physical Science

S8P1. Students will be familiar with the scientific view of the nature of matter and with how that view evolved

S8P1.a. Students will classify and identify properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).

S8P1.b. Students will classify and identify changes in matter as physical (i.e., phase change) or chemical (development of a gas, formation of precipitate, and change in color).

S8P1.e. Students will distinguish between atoms and molecules and explain that atoms and molecules are perpetually in motion.

S8P1.f. Students will demonstrate, using drawings and models, the movement of atoms in a solid, liquid, and gaseous state.

Grade 6 Earth Science

S6E7. Students will be familiar with the various sources of energy and with their uses and conservation.

S6E7.b. Students will research and locate various alternative energy sources (i.e., **hydroelectricity**, nuclear, geothermal, thermal, wind, solar) to compare their advantages and disadvantages.

Grade 8 Physical Science

S8P2. Students will be familiar with the forms and transformations of energy.

S8P2.a. Students will relate potential and kinetic energy to the Law of Conservation of Matter.

S8P2.b. Students will describe different forms of energy and their sources.

S8P2.c. Students will describe how heat can be transferred through matter by the collisions of atoms (conduction) or through space (radiation). In a liquid or gas, currents will facilitate the transfer of heat (convection).

S8P4. Students will be familiar with the wave nature of sound and electromagnetic radiation.

S8P4.a. Students will identify the properties of waves.

Grade 8 Physical Science

S8P3. Students will be familiar with the relationship between force mass and the motion of objects.

S8P3.a. Students will explore the relationship between velocity and acceleration.

S8P3.b. Students will investigate forces and their relationship to motion, Newton's Three Laws of Motion.

S8P5. Students will recognize gravitational, electrical, and magnetic forces as major kinds of forces acting in nature.

S8P5.a. Students will explain that every object exerts gravitational force on every other object and that the force exerted depends on how much mass the objects have and how far apart they are.

Reading in All Curriculum Areas Grades 6-8

Read technical text related to various subject areas

Discussing books

Discuss messages and themes from books in all subject areas

Respond to a variety of texts in multiple modes of discourse

Relate messages and themes from one subject area to messages and themes in another area

Vocabulary

Demonstrate an understanding of contextual vocabulary in various subjects

Use content vocabulary in writing and speaking

Explore understanding of new words found in subject area texts

Establishing context

Explore life experiences related to subject area content

Discuss in both writing and speaking how certain words are subject area related

Determine strategies for finding content and contextual meaning for unknown

Words

Georgia Physical Science

Georgia Physical Science

SPS7. Students will be familiar with the forms and transformations of energy.

SPS7. a. Students will explore the conservation of energy in terms of potential and kinetic energy

SPS7. d. Students will demonstrate the flow of energy in phase changes through the use of a phase diagram.

SPS8. Students will be familiar with the relationship between force, mass, and motion a. Students will calculate velocity and acceleration.

SPS8.b. Students will explore the relationship between force, mass and motion.

SPS8.c. Students will demonstrate a conceptual understand of Newton's Laws of

Motion.

SPS8.d. Students will calculate force given its mass and acceleration.

SPS8.e. Students will explain the difference in mass and weight.

SPS9. Students will be familiar with the properties of waves.

SPS9.b. Students will investigate the phenomena of reflection, refraction, interference, and diffraction.

Georgia Reading in the Curriculum Areas- High School

SCSh6. Students will enhance reading in all curriculum areas by:

1a. Reading in All Curriculum Areas

- Read technical text related to various subject areas

2b. Discussing books

- Respond to a variety of texts in multiple modes of discourse.
- Relate messages and themes from one subject area to messages and themes in another area.
- Evaluate the merit of texts in every subject discipline.

c. Vocabulary

- Demonstrate an understanding of contextual vocabulary in various subjects.
- Use content vocabulary in writing and speaking.
- Explore understanding of new words found in subject area texts.

d. Establishing context

- Explore life experiences related to subject area content.
- Discuss in both writing and speaking how certain words are subject area related.
- Determine strategies for finding content and contextual meaning for unknown words.

4. Florida Sunshine State Standards

Math

MA.B.1.3.4: The student constructs, interprets, and uses scale drawings such as those based on number lines and maps to solve real-world problems.

Grade level expectations

The student:

Sixth

1. knows proportional relationships in scale drawings
2. uses scale drawings to solve real-world problems including distance (as in map reading)

Seventh

1. knows an appropriate scale needed to produce a proportional drawing or model
2. knows proportional relationships used in scale drawings
3. produces a scale drawing

Eighth

1. interprets and applies various scales including those based on number lines, graphs, models and maps (scale may include rational numbers)
2. constructs and uses scale drawings to recreate a given situation

MA.B.2.3.1: The student uses direct (measured) and indirect (not measured) measures to compare a given characteristic in either metric or customary units.

Grade level expectations

The student:

Sixth

1. compares objects according to their length, weight or mass, and capacity using customary or metric units.
2. measures length, weight or mass, and capacity using appropriate measuring instruments.

Seventh

1. measures length, weight or mass, and capacity or volume using customary or metric units
2. knows relationships between metric units of mass and capacity (for example, one cubic centimeter of water weighs one gram)
3. finds measures of length, weight or mass and capacity or volume using proportional relationships and properties of similar geometric figures (for example, using shadow measurement and properties of similar triangles to find the height of a flagpole)

Eighth

1. finds measures of length, weight or mass, and capacity of volume using proportional relationships and properties of similar geometric figures

MA.D.1.3.2: The student creates and interprets tables, graphs, equations and verbal descriptions to explain cause-and-effect relationships

Grade level expectations

The student:

Sixth

1. interprets and creates function tables and graphs (first quadrant)
2. substitutes values for variables in expressions and describes the results or patterns observed
3. graphs (first quadrant) functions from function tables to explain cause-and-effect relationships

Seventh

1. interprets and creates function tables and graphs (all four quadrants)
2. writes expressions and equations to describe relationships
3. graphs equations to explain cause-and-effect relationships

Eighth

1. interprets and creates tables and graphs (function tables)
2. writes equations and inequalities to express relationships
3. graphs equations and inequalities to explain cause-and-effect relationships
4. interprets the meaning of the slope of a line from a graph depicting a real-world situation

MA.E.1.3.1: The student collects, organizes and displays data in a variety of forms, including tables, line graphs, charts, bar graphs, to determine how different ways of presenting data can lead to different interpretations

Grade level expectations

The student:

Sixth

1. reads and analyzes data displayed in a variety of forms (charts, pictographs, stem-and-leaf plots)
2. generates and collects data for analysis
3. chooses appropriate titles, scales, labels, keys and intervals for displaying data in graphs
4. constructs, interprets and explains displays of data, such as tables and graphs (single- and multiple-bar graphs and single- and multiple-line graphs)

Seventh

1. generates and collects data for analysis
2. interprets and analyzes data presented in a variety of forms, including box-and-whisker graphs and scatter plots

3. constructs, interprets and explains displays of data such as tables and graphs (circle graphs, single- and multiple-bar graphs and single and multiple line graphs) and explains how different displays of data lead to different interpretations

Eighth

1. reads and interprets data displayed in a variety of forms, including histograms
2. constructs and interprets displays of data, (including circle, line, bar, and box-and-whisker graphs) and explains how different displays of data can lead to different interpretations.

MA.E.3.3.1: The student formulates hypotheses, designs experiments, collects and interprets data and evaluates hypotheses by making inferences and drawing conclusions based on statistics (range, mean, median and mode) and tables, graphs and charts.

Grade level expectations

The student:

Sixth

1. with classmates, formulates hypotheses based on research and prior data, designs an appropriate experiment, collects and analyses data using appropriate statistics and displays and interprets results in appropriate tables or graphs

Seventh

1. formulates a hypothesis and designs an experiment
2. performs the experiment and collects, organizes and displays the data
3. evaluated the hypothesis by making inferences and drawing conclusions based on statistical results

Eighth

1. formulates a hypothesis and designs an experiment
2. performs the experiment and collects, organizes and displays the data
3. evaluated the hypothesis by making inferences and drawing conclusions based on statistical results

SCIENCE

SC.A.2.3.1: The student describes and compares the properties of particles and waves.

Grade level expectations

The student:

Sixth

1. understands that particles and objects may be either neutral or have a positive or negative charge
2. knows the properties of waves (frequency, amplitude, wavelength)
3. knows hoe to compare and contrast the properties of particles and waves

Seventh

1. knows that charged particles and objects will attract or repel each other
2. knows the relationship between frequency and wavelength (the greater the frequency of the wave, the smaller the wavelength of the wave)

Eighth

1. knows that matter is mostly neutral, but that particles can attain a charge by the gain or loss of electrons
2. understands the relationship between the energy of a wave and its frequency (the greater the frequency of the wave, the greater the energy of the wave)
3. understands the relationship of energy and wavelength to the electromagnetic spectrum

SC.B.1.3.6: The student knows the properties of waves (e.g. frequency, wavelength, and amplitude); that each wave consists of a number of crests and troughs; and the effects of different media on waves

Grade level expectations

The student:

Eighth

1. knows that sound travels in a medium (cannot travel in a vacuum) and travels at different speeds through various media
2. knows the parts of a wave (crest, trough, wavelength, amplitude)
3. understands that wavelength determines the colors of visible light
4. understands that wavelength determines the pitch of sound
5. knows that waves vary greatly in character (for example, sound, ultraviolet, infrared, ocean waves)

SC.C.1.3.1: The student knows that the motion of an object can be described by its position, direction of motion and speed

Grade level expectations

The student:

Sixth

1. knows that a change in motion and position can be measured
2. knows ways to measure time intervals
3. knows ways to estimate speed

Seventh

1. knows that the motion of an object can be described by its position, direction of motion and speed

Eighth

1. knows that speed, velocity and acceleration can be calculated, estimated and defined
2. knows that the magnitude of linear acceleration can be calculated

SC.C.1.3.2: The student knows that vibrations in materials set up wave disturbances that spread away from the source (e.g. sound and earthquake waves)

Grade level expectations

The student:

Sixth

1. uses common items (a pebble dropped in water, a marble dropped in sand) to demonstrate that vibrations in materials set up visible disturbances that spread away from a force in all directions

Seventh

1. knows factors that influence the amount of damage vibrations can cause
2. knows intensity of some common waves
3. knows some causes and effects of waves

Eighth

1. knows ways to measure the frequency of waves
2. knows some technological devices that use wave energy (for example, sonar, ultrasound, laser)

SC.C.2.3.5: The student understands that an object in motion will continue at a constant speed and in a straight line until acted upon by a force and that an object at rest will remain at rest until acted upon by a force.

Grade level expectations

The student:

Sixth

1. knows that an object at rest will stay at rest unless acted upon by an outside force.
2. knows objects in motion will remain in motion unless acted upon by an outside force.

Seventh

Content covered at 6th and 8th grades

Eighth

1. understands that an object in motion will continue at a constant speed and in a straight line until acted upon by a force and that an object at rest will remain at rest until acted upon by a force.

SC.C.2.3.6: The student explains and shows the ways in which a net force (that is, the sum of all acting forces) can act on an object (e.g. speeding up an object traveling in the same direction as the net force, slowing down an object traveling in the direction opposite of the net force).

Grade level expectations

The student:
Eighth

1. Knows ways in which a net force (for example the sum of all acting forces) can act on an object (e.g. speeding up an object traveling in the same direction as the net force, slowing down an object traveling in the direction opposite of the net force).

SC.D.1.3.3: The student knows how conditions that exist in one system influence the conditions that exist in other systems.

Grade level expectations

The student:
Sixth

1. knows that different events on the Earth change features on Earth (for example, hurricanes, earthquakes, volcanoes).

Seventh

1. understands that changes on the surface of the Earth affect living systems.

Eighth

1. knows ways conditions that exist in one system influence the conditions that exist in the other systems (for example, the relationship between mountain building, island formation and trench formation; interactions between the atmosphere and hydrosphere affect weather patterns).

SC.H.1.3.2: The student knows that the study of events that led scientists to discoveries can provide information about the inquiry process and its effects.

Grade level expectations

The student:

Sixth

1. uses systematic, scientific processes to develop and test hypotheses.
2. knows that the scientific method is a process that involves a logical and empirical but flexible approach to problem solving.

Seventh

1. uses systematic, scientific processes to solve problems and reach conclusions.

Eighth

1. extends and refines use of systematic, scientific processes to develop and test hypotheses.
2. knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects.

5. National Science Education Standards

Science as Inquiry

CONTENT STANDARD A:

As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science

CONTENT STANDARD B:

As a result of their activities in grades 5-8, all students should develop an understanding of

- Properties and changes of properties in matter
- Motions and forces
- Transfer of energy

Earth and Space Science

CONTENT STANDARD D:

As a result of their activities in grades 5-8, all students should develop an understanding of

- Structure of the earth system

Science and Technology

CONTENT STANDARD E:

As a result of activities in grades 5-8, all students should develop

- Abilities of technological design
- Understandings about science and technology

Science in Personal and Social Perspectives

CONTENT STANDARD F:

As a result of activities in grades 5-8, all students should develop understanding of

- Personal health
- Populations, resources, and environments
- Natural hazards
- Risks and benefits

- Science and technology in society

History and Nature of Science

CONTENT STANDARD G:

As a result of activities in grades 5-8, all students should develop understanding of

- Science as a human endeavor
- Nature of science
- History of science

Science Content Standards: 9-12

Science as Inquiry

CONTENT STANDARD A: As a result of activities in grades 9-12, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science

CONTENT STANDARD B: As a result of their activities in grades 9-12, all students should develop an understanding of

- Motions and forces

Earth and Space Science

CONTENT STANDARD D: As a result of their activities in grades 9-12, all students should develop an understanding of

- Energy in the earth system
- Geochemical cycles

Science and Technology

CONTENT STANDARD E: As a result of activities in grades 9-12, all students should develop

- Abilities of technological design
- Understandings about science and technology

Science in Personal and Social Perspectives

CONTENT STANDARD F: As a result of activities in grades 9-12, all students should develop understanding of

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

History and Nature of Science

CONTENT STANDARD G: As a result of activities in grades 9-12, all students should develop understanding of

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives