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The Department's Educational Philosophy

We believe that students should be exposed to the process of scientific inquiry so they can acquire and interpret scientific knowledge, and begin to realize the wider applicability of scientific problem-solving methods. By making the laboratory the focal point of learning, we seek to foster students' appreciation for the experience of doing science.

Guiding Principles

- Students must be able to collect and analyze data and formulate hypotheses.
- Inductive and deductive problem-solving skills are central to science education.
- An effective program in science addresses the limitations of data and conclusions.
- Students should be able to use or design a strategy for testing scientific concepts.
- A comprehensive science program will emphasize the delicate checks and balances in man's abiotic and biotic environments and the stresses upon these ecosystems, which could affect the destiny of the world.
- Science is integrally related to mathematics.
- An effective science program builds students' ability to communicate accurately and precisely.
- An effective science program stresses both cooperative and independent learning.

EARTH SCIENCE (AE): COURSE #412

Course Frequency: Six times per six-day cycle
Credits Offered: Five
Prerequisites: Recommendation of the eighth-grade science staff

Background to the Curriculum

The earth science courses at Acton-Boxborough are designed for students who are curious about their physical world. They are encouraged to look around and become thoughtful observers of everyday scenes and events that they may not have noticed before. Students frequently say "Oh, I always wondered why that happens!"; it is easy for them to see its relevance to their lives.

Earth science covers topics that informed citizens need to understand, such as groundwater supplies, soil conservation, pollution, and our contribution to global warming. These issues will have a direct and major impact on these students' lives; the better they understand how the earth works, the better policymakers, voters, homeowners, businesspeople, and consumers they will be.

Earth science is also aimed at students who feel they could benefit from another year of math or descriptive science (along with biology) before venturing into the more abstract realms of chemistry and physics. Earth science introduces, then applies, some of the major concepts from these fields using a limited amount of mathematics.

Earth science has been part of the program of studies at Acton-Boxborough for a long time, with honors and standard prep levels added within the past decade in order to accommodate all learning styles and paces.

All of the levels cover the same material for the most part; the main difference between them is the pace and depth of exploration.

In the past, earth science has comprised a significant portion of the currently-required 10^{th}-grade MCAS general science exam. Recently, the state has taken steps toward a series of yearly subject-specific tests instead. If this change is made as expected, a satisfactory score on the earth science exam would satisfy half of the required MCAS test series.

The earth science courses at Acton-Boxborough are extensively aligned with the state frameworks – so much so that we have taken our learning objectives directly from them in many cases. (See Massachusetts Department of Education, May 2001, Massachusetts Science and Technology Curriculum Frameworks)

The new subject-specific MCAS exams should help us continue to refine our standards to match the state's expectations.

Core Topics/Questions/Concepts/Skills

The study of the earth system can be divided into five general topics:

- Maps and mapping (geography)
- The earth itself (geology)
- The atmosphere (meteorology)
- Space (astronomy and cosmology)
- The oceans (physical and chemical oceanography, not including marine biology)

Our emphasis will be on the interaction of these components, the flow of energy through them, and the role of the earth's drive toward equilibrium in its evolution.

Core Skills

1. Students should be able to distinguish between a **force/property of matter** (gravity, density, temperature), a **process** (erosion, convection, nuclear fusion), and the physical **product** of the force or process (a solar nebula, wind, a drumlin, a heavier element).
2. Students should be able to deconstruct a physical process in order to identify the forces driving it.
3. Given a set of terms, students should be able to delineate the relationship(s) between them by categorizing them, constructing a concept map or diagram, etc.
4. Students should be able to identify a phenomenon's role in the earth system's drive toward equilibrium (e.g., crust is consumed in one place but created in another, excess heat at the equator is redistributed toward the poles by the atmosphere and oceans, etc.)
5. Students should be able to access information presented in the form of a graph, table, flow chart, etc. They should be able to extract specific facts from these forms, and also be able to identify trends and relationships in the data.
6. Students should become competent scientific communicators, both in informal labs and formal lab reports. Elements of this should include:
   a. identifying the question being asked and clearly restating it;
   b. breaking it down into its component parts;
   c. addressing each part with:
      - a clear statement of hypothesis,
      - supporting the hypothesis with facts and/or examples,
      - making connections to other parts of the question as required, **or**
      - making predictions of outcomes as required.

Course-End Learning Objectives

Learning objective	Corresponding state standards, *where applicable*
Maps and Mapping	
1] Distinguish between latitude and longitude and use them to pinpoint locations on a map.	
2] Distinguish between the magnetic and geographic poles.	
3] Be able to access and interpret information (e.g., scale, elevation, latitude/longitude, distance) from a variety of map types.	
4] Use a magnetic compass to find a bearing and a student's unique stride to measure distance in a local area.	
5] Draft a map of a local area using the bearing and distance data gathered by student teams.	
Geology	
1] Explain how scientists study the Earth system.	
2] Compare the physical properties and the mineral combinations found in rocks.	3.5
3] Explain how the composition and arrangement of atoms determine a mineral's physical and chemical characteristics.	3.5
4] Describe the rock cycle, and the processes that are responsible for the formation of igneous, sedimentary, and metamorphic rocks. Compare the physical properties of these rock types.	3.5
5] Explain both physical and chemical weathering and how these processes lead to the formation of sediments, soils, soil texture and structure, and soil horizons.	3.1
6] Explain how water flows into and through a watershed (e.g., aquifers, wells, porosity, permeability, water table, capillary water, runoff).	3.3
7] Compare and contrast the processes of the hydrologic cycle, including evaporation, condensation, precipitation, runoff, infiltration, and transpiration.	3.4
8] Describe how glaciers, gravity, wind, waves, and rivers cause weathering and erosion. Give examples of how the effects of these processes can be seen in our local environment.	3.1
9] Trace the development of a lithospheric plate from its growing margin at a divergent boundary to its destructive margin at a convergent boundary. Explain the relationship between convection currents and the motion of the lithospheric plates.	3.11
10] Relate earthquakes, volcanic activity, mountain building and tectonic uplift to plate movements.	3.12
11] Explain how seismic data is used to reveal the interior structure of the layered earth.	3.8

12] Describe the absolute and relative dating methods used to measure geologic time (e.g., index fossils, radioactive dating, law of superposition, and cross-cutting relationships).	3.6	
13] Describe the evolution of the solid earth in terms of the major geologic eras.	3.7	
<u>Oceanography</u>		
1] Explain the dynamics of oceanic currents, including upwelling, density and deep water currents, the local Labrador Current and Gulf Stream, and their relationship to the global circulation within the marine environment and climate.	1.7	
2] Describe the effects of longshore currents, storms and artificial structures (jetties, sea walls) on coastal erosion in Massachusetts.	1.8	
3] Explain what causes the tides and describe how they affect the coastal environment.	1.9	
<u>Meteorology</u>		
1] Explain how the transfer of energy through radiation, conduction, and convection contributes to global atmospheric processes (storms, winds).	1.2	
2] Explain how the layers of the atmosphere affect the dispersal of incoming radiation through reflection, absorption, and reradiation.	1.3	
3] Provide examples of how the unequal heating of the earth and the Coriolis Effect influence global circulation patterns and their impact on Massachusetts weather and climate (convection cells, trade winds, westerlies, polar easterlies, land/sea breezes, mountain/valley breezes).	1.4	
4] Explain how the revolution of the earth and the inclination of the axis of the earth cause the earth's seasonal variations (equinox and solstices).	1.5	
5] Describe how the inclination of the incoming solar radiation can impact the amount of energy received by a given surface area.	1.5	
6] Describe the various conditions associated with frontal boundaries and cyclonic storms (e.g., thunderstorms, winter storms – nor'easters, hurricanes, tornadoes) and their impact on human affairs, including storm preparations.	1.6	
<u>Astronomy</u>		
1] Identify the sources of internal and external energy of the earth (radioactive decay, gravity, solar energy).	1.1	
2] Describe the components of the electromagnetic spectrum and give examples of its impact on our lives.	1.1	
3] Explain the Big Bang Theory and discuss the evidence that supports it (background radiation, Doppler effect, and red shift).	4.1	
4] Use the Hertzsprung-Russell Diagram to explain the life histories of stars.	4.2	

5] Compare and contrast the motions of rotation and revolution of orbiting bodies (day, year, solar and lunar eclipses). Describe the influence of gravity and inertia on these motions.	4.3
6] Explain how the sun, earth, and solar system formed from a nebula cloud of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 billion years ago.	4.4

Assessment

- Tests, quizzes and formal labs – 70%
- Class work, informal labs, homework, participation – 30%
- Extra credit projects are occasionally offered; extra credit points are added to the lowest test score
- Projects may be assigned at teacher's discretion and generally count as a test grade.
- Tests include a variety of question types to develop a variety of cognitive skills. Some examples:
  1. objective
     a. multiple choice, true/false, fill-ins (with or without a word bank), matching
  2. short open-response
     a. reading/analyzing information from a graph or chart
     b. making a chart or graphic organizer to compare and contrast two ideas
     c. arranging the steps of a process in the proper order
     d. predicting an outcome based on information provided
  3. long open-response
     1. Describe and evaluate the evidence supporting a scientific theory
     2. Take a position on a controversy and support your viewpoint
     3. Explain how a small concept (e.g., the heat capacity of water) fits into the broader scientific picture (how Earth is able to sustain life)

Technology and Health Learning Objectives Addressed in This Course

(This section is for faculty and administrative reference; students and parents may disregard.)

Course activity: skills &/or topics taught	Standard(s) addressed through this activity
1] Students use: – word processors to write/edit/rewrite essays – websites for activities and research **2]** For extra credit projects, students may use: digital cameras, web cams, or camcorders **3]** Depending on teacher assignment and interest, the following have also been used in project work: computer animations or simulations, PowerPoint presentations, CAD	

Materials and Resources

Text:

Sager, Robert et al. Modern Earth Science. Austin, TX: Holt, Rinehart and Winston, 2002

A variety of other sources are used to supplement the text, including news articles, other texts, and websites, as well as teacher-generated material.