# MASSACHUSETTS
# Science and Technology/Engineering Curriculum Framework
# Earth and Space Science, Grade 9 or 10
# *Earth Science: Geology, the Environment, and the Universe* © 2005

| LEARNING STANDARD | PAGE REFERENCES |
|---|---|
| **1. Matter and Energy in the Earth System**<br>*Broad Concept:* The earth has internal and external sources of energy. The sun is the major external source of energy while the primary sources of internal energy are generated through radioactive decay and gravitational attraction from the earth's original formation. | |
| **1.1 Identify the earth's principal sources of internal and external energy, e.g., radioactive decay, gravity, solar energy.** | SE: 275-277, 578-579, 683-684<br>*Discovery Lab* 683<br>TWE: CB 578, 764<br>A 683<br>DIS 694 |
| *Broad Concept:* Two fundamental energy concepts included in the earth system are gravity and electromagnetism. | |
| **1.2 Describe the components of the electromagnetic spectrum and give examples of its impact on our lives.** | SE: 37-41, 747-748<br>*GeoDigest* 858<br>TWE: D 37<br>ACT 40<br>CFU 41<br>R 41<br>A 41 |
| 1.3 Describe the characteristics of waves (wavelength, frequency, velocity, amplitude). | SE: 37-41, 315, 399-400, 747-748<br>TWE: ITI 38, 747<br>A 41, 747<br>CB 494D |
| 1.4 Describe the nature of the continuous emission and absorption spectrum that indicates the composition of stars. | SE: 811-812, 817-820<br>*GeoLab* 826-827<br>TWE: DI 811<br>CB 818<br>TPK 818 |
| *Broad Concept:* Global atmospheric processes are driven by energy from the sun, unequal heating between the equator and poles, the earth's rotation and revolution, and the influence of land and water. Human affairs can dramatically influence and be influenced by atmospheric phenomena. | |
| **1.5 Explain how the transfer of energy through radiation, conduction, and convection contributes to global atmospheric processes, e.g., storms, winds.*** | SE: 275-277, 282, 290-291, 299-304, 305-311<br>TWE: A 276<br>CFU 277<br>CB 300 |
| 1.6 Explain how the layers of the atmosphere affect the dispersal of incoming radiation through reflection, absorption, and reradiation. | SE: 273-277<br>TWE: M 276<br>A 277<br>ACT 282 |

| LEARNING STANDARD | PAGE REFERENCES |
|---|---|
| **1.7 Provide examples of how the unequal heating of the earth and the Coriolis Effect influence global circulation patterns, and show their impact on Massachusetts weather and climate, e.g., convection cells, trade winds, westerlies, polar easterlies, land/sea breezes, mountain/valley breezes.** | SE: 305-311, 404<br>TWE: ITI 305<br>TPK 306<br>CL 308<br>CON 330 |
| **1.8 Explain how the revolution of the earth and the inclination of the axis of the earth cause the earth's seasonal variations (equinoxes and solstices).*** | SE: 370, 759-762<br>*Section Assessment* 767<br>TWE: E 370, 762<br>M 760<br>ITI 760<br>A 760<br>AES 760 |
| 1.9 Describe how the inclination of the incoming solar radiation can impact the amount of energy received by a given surface area. | SE: 300-301, 362<br>*MiniLab* 302, 761<br>TWE: ITI 301<br>A 302<br>CON 437<br>D 758 |
| **1.10 Describe the various conditions associated with frontal boundaries and cyclonic storms (e.g., thunderstorms, winter storms [nor'easters], hurricanes, and tornadoes) and their impact on human affairs, including storm preparations.** | SE: 308-311, 329-333, 334-340, 341-346<br>TWE: ACT 310<br>R 311<br>CB 328C-D<br>A 340, 346 |
| *Broad Concept:* Oceans redistribute matter and energy around the earth, through surface and deepwater currents, tides, waves, and interaction with other earth spheres. | |
| **1.11 Explain the dynamics of oceanic currents, including upwelling, density, and deep water currents, the local Labrador Current and the Gulf Stream, and their relationship to global circulation within the marine environment and climate.*** | SE: 396-398, 403-405, 411 #23<br>*GeoLab* 406-407<br>*Science in the News* 408<br>TWE: ESJ 404<br>A 405<br>R 405<br>E 439 |
| **1.12 Describe the effects of longshore currents, storms, and artificial structures (e.g., jetties, sea walls) on coastal erosion in Massachusetts.** | SE: 413-419<br>TWE: TL 165<br>DIS 196, 419<br>CB 412C, 416<br>EC 416, 419<br>RE 418 |

| LEARNING STANDARD | PAGE REFERENCES |
|---|---|
| **1.13 Explain what causes the tides and describe how they affect the coastal environment.** | SE: 400-403, 764<br>TWE: CB 384D, 403<br>CON 402<br>ITI 403<br>AC 403<br>ACT 403<br>E 764<br>A 767 |
| *Broad Concept:* Scientists use various instruments and methods to investigate the earth as a system. | |
| **1.14 Explain how scientists study the earth system through the use of a combination of ground-based observations, satellite observations, and computer models of the earth system, and why it is necessary to use all of these tools together.** | SE: 37-41, 312-316<br>TWE: DI 38<br>CL 38<br>CON 38<br>EC 39<br>P 312<br>UAA 315<br>E 673 |
| **2. The Earth's Sources of Energy**<br>*Broad Concept:* Numerous earth resources are used to sustain human affairs. The abundance and accessibility of these resources can influence their use. | |
| 2.1 Recognize, describe, and differentiate between renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [Ura-235]) sources of energy. | SE: 655-658, 683-689, 690-697<br>TWE: A 656, 658<br>CB 682C-D<br>CL 720 |
| 2.2 Explain the advantage and limitations of renewable sources of energy. | SE: 690-697<br>*Section Assessment* 697<br>*Science in the News* 736<br>TWE: P 672<br>CB 696, 701 |
| 2.3 Explain the advantage and limitations of nonrenewable sources of energy. | SE: 683-689, 716-717<br>*MiniLab* 718<br>TWE: P 685<br>AC 686<br>CL 695 |
| 2.4 Describe ways in which people have tried to control the use of renewable and nonrenewable sources of energy, e.g., scientific advances, prices. | SE: 659-663, 698-703, 732-733<br>*Design Your Own GeoLab* 704-705<br>TWE: ESJ 660<br>E 661<br>DIS 702<br>CFU 703 |
| 2.5 Describe the effects on the environment of using both renewable and nonrenewable sources of energy. | SE: 716-723, 724-729, 730-733<br>TWE: ESJ 667<br>CB 717, 726<br>A 723, 729<br>P 727<br>R 733 |

| LEARNING STANDARD | PAGE REFERENCES |
|---|---|
| 2.6 Describe ways in which scientists are addressing effects on the environment of using both renewable and nonrenewable sources of energy, e.g., creation of new technologies. | SE: 698-703, 722-723, 728-729, 732-733<br>*Earth Science Online* 694<br>*Science & the Environment* 706, 736<br>TWE: CD 719 |
| **3. Earth Processes and Cycles**<br>*Broad Concept:* Interactions among the lithosphere, hydrosphere, and atmosphere have resulted in ongoing evolution of the earth system over geologic time. | |
| **3.1 Explain that weather is the most significant source of erosion and how both physical and chemical weathering lead to the formation of sediments and soils, affect the shape of rocks, and create specific landscapes depending on what weathering process is dominant under a specific climate.** | SE: 153-161, 167-173<br>*MiniLab* 163<br>*GeoLab* 174-175<br>TWE: CB 152C-D<br>DIS 155<br>D 155<br>CON 159, 165 |
| **3.2 Describe how glaciers, gravity, wind, temperature changes, waves, and rivers cause weathering and erosion. Give examples of how the effects of these processes can be seen in our local environment.*** | SE: 162-166, 181-190, 191-197, 198-203, 222-227<br>TWE: ACT 158<br>RE 158<br>AES 164<br>ESJ 165<br>A 166 |
| 3.3 Explain the nitrogen and carbon cycles and their roles in the improvement of soils for agriculture. | SE: 664<br>TWE: AC 720 |
| 3.4 Describe the evolution of the atmosphere. | SE: 584-588, 599 #22, 664<br>TWE: CB 270C, 576C-D<br>R 588 |
| 3.5 Describe how the oceans store carbon dioxide as dissolved $HCO_3$ and $CaCO_3$ precipitate. | SE: 392 |
| *Broad Concept:* Water is continually being recycled by the hydrologic cycle through the watersheds, oceans, and the atmosphere by processes such as evaporation, condensation, precipitation, runoff, and infiltration. This life-giving cycle is continually and increasingly impacted by human affairs. | |
| **3.6 Explain how water flows into and through a watershed, e.g., aquifers, wells, porosity, permeability, water table, capillary water, runoff. *** | SE: 211-221, 222-227, 239-243<br>*Discovery Lab* 211<br>TWE: CB 210C, 212<br>P 213<br>M 214<br>CON 215 |
| **3.7 Compare and contrast the processes of the hydrologic cycle including evaporation, condensation, precipitation, surface runoff and groundwater percolation, infiltration, and transpiration.** | SE: 211-212, 290-291<br>*MiniLab* 290<br>TWE: IM 212<br>R 243, 291<br>A 290<br>TPK 392 |

| LEARNING STANDARD | PAGE REFERENCES |
|---|---|
| *Broad Concept:* Rocks and minerals are continually being modified within the rock cycle. | |
| **3.8 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.*** | SE: 99-106, 107-113, 121-127, 128-132, 133-139<br>*MiniLab* 108<br>*GeoLab* 114-115, 140-141<br>*Discovery Lab* 121<br>TWE: DIS 135 |
| 3.9 Compare the physical properties and the mineral combinations found in rocks. | SE: 77-83, 84-91<br>*Discovery Lab* 77<br>*Problem-Solving Lab* 88<br>*Design Your Own GeoLab* 92-93<br>TWE: CON 81<br>UST 82<br>CL 86<br>RE 86<br>P 89 |
| 3.10 Explain how the composition and arrangement of atoms determine a mineral's physical and chemical characteristics. | SE: 77-83<br>*MiniLab* 79<br>TWE: ITI 78<br>TPK 80<br>M 81 |
| *Broad Concept:* Geologic time can be determined by analyzing rocks and fossils. | |
| **3.11 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.*** | SE: 557-561, 562-565, 566-569<br>*Discovery Lab* 553<br>*MiniLab* 558<br>*Problem-Solving Lab* 560<br>TWE: DI 558<br>M 559<br>A 565<br>R 569 |
| 3.12 Describe the evolution of the solid earth in terms of the major geologic eras. | SE: 580-583, 601-604, 605-608, 612-615, 625-627, 635-638<br>*Design Your Own GeoLab* 570-571<br>*Mapping GeoLab* 594-595<br>TWE: CB 581<br>A 583 |
| *Broad Concept:* The earth is a system of interacting spherical layers with each layer having distinct characteristic compositions, physical properties, and processes. | |
| **3.13 Explain how seismic data is used to reveal the interior structure of the layered earth.** | SE: 502-504<br>TWE: CB 494C, 503<br>A 504<br>CFU 504 |
| 3.14 Explain how seismic data is used to locate an earthquake epicenter. | SE: 498-499, 500-504, 505-510<br>*Problem-Solving Lab* 502<br>*MiniLab* 508<br>*GeoLab* 516-517<br>TWE: CB 501<br>M 501<br>A 501<br>ITI 509 |

| LEARNING STANDARD | PAGE REFERENCES |
|---|---|
| 3.15 Recognize the magnitude values of earthquakes as measured by the Richter Scale and give examples of relative damage that would be incurred at each magnitude. | SE: 505-510<br>TWE: CB 494C-D, 506<br>ITI 506<br>E 507<br>DI 508<br>R 510<br>A 510<br>CFU 510<br>ESJ 513 |
| 3.16 Explain how the magnetic field of the earth is produced. | TWE: D 451 |
| 3.17 Explain how the Van Allen Belts protect the biosphere. | SE: 807*<br>*This reference describes Van Allen Belts without mentioning how it protects the biosphere. |
| 3.18 Explain how paleomagnetic patterns, preserved in rocks, provide evidence of the earth's magnetic field over geologic time. | SE: 451-452<br>*Mapping GeoLab* 464-465<br>TWE: ITI 451<br>M 452 |
| *Broad Concept:* Plate tectonics operating over geologic time have altered the features of land, sea, and mountains by both constructive and destructive processes. | |
| **3.19 Trace the development of a lithospheric plate from its growing margin at a divergent boundary (mid-ocean ridge) to its destructive margin at a convergent boundary (subduction zone). Explain the relationship between convection currents and the motion of the lithospheric plates.*** | SE: 448-454, 455-459, 460-463<br>*MiniLab* 457<br>*Problem-Solving Lab* 458<br>TWE: CB 442C-D<br>ITI 453, 455<br>CFU 459<br>R 463 |
| **3.20 Relate earthquakes, volcanic activity, mountain building, and tectonic uplift to plate movements.** | SE: 455-459, 473, 484-487, 509-510<br>TWE: CB 457, 470D<br>AC 457<br>ITI 485, 509<br>CFU 487 |
| 3.21 Relate the effects of sudden seafloor movements to the generation of tsunamis. | SE: 513<br>TWE: ESJ 513<br>R 515 |
| 3.22 Provide examples of how societies have been affected by tectonic activity (e.g., hazards from eruptions and earthquakes, bedrock type and soil conditions, building designs). | SE: 480-487, 511-513<br>*Earth Science Online* 484<br>*Internet GeoLab* 488-489<br>*Science & the Environment* 490<br>*Science in the News* 518<br>TWE: DI 512<br>EC 514<br>R 515 |

| LEARNING STANDARD | PAGE REFERENCES |
|---|---|
| **4. The Origin and Evolution of the Universe**<br>*Broad Concept:* The origin of the universe, between 10 and 20 billion years ago, remains one of the greatest questions in science. | |
| **4.1 Explain the Big Bang Theory and discuss the evidence that supports it (background radiation, and Relativistic Doppler effect ~ red shift).** | SE: 818-819, 842-846, 847-851<br>*Problem-Solving Lab* 843<br>*MiniLab* 845<br>TWE: AC 314<br>A 846<br>CFU 851 |
| 4.2 Define the unit of distance called a light year. | SE: 815<br>TWE: E 815 |
| *Broad Concept:* Gravity influences the formation and life cycles of galaxies, including our own Milky Way Galaxy, stars, planetary systems, and residual material left from the creation of the solar system. These objects move in regular patterns under the influence of gravity. | |
| **4.3 Use the Hertzsprung-Russell Diagram to explain the life histories of stars.** | SE: 819-820, 821-825<br>TWE: CB 819, 823<br>A 820<br>DI 822 |
| 4.4 Compare and contrast the final three outcomes of stellar evolution based on mass (black hole, neutron star, white dwarf). | SE: 822-825, 831 #16, 831 #22<br>TWE: A 825<br>R 825 |
| *Broad Concept:* Our solar system is composed of a star, planets, moons, asteroids, comets, and residual material left from the evolution of the solar system over time. | |
| **4.5 Compare and contrast the motions of rotation and revolution of orbiting bodies, e.g., day, year, solar/lunar eclipses. Describe the influence of gravity and inertia on these motions.** | SE: 758-767, 776-779<br>*MiniLab* 777<br>TWE: CB 764, 776<br>D 764<br>A 767<br>ESJ 777<br>DI 777<br>CFU 779 |
| 4.6 Explain Kepler's Laws of Motion. | SE: 776-778, 803 #27 |
| 4.7 Compare and contrast the various instrumentation used to study deep space and the solar system, e.g., refracting telescope, reflecting telescope, radio telescope, spectrophotometer. | SE: 747-752<br>*Discovery Lab* 775<br>*Science in the News* 800, 828<br>*National Geographic* 902-907<br>TWE: CB 746C<br>E 749<br>DI 749<br>ESJ 750<br>R 752 |
| **4.8 Explain how the sun, earth, and solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 billion years ago.*** | SE: 793-797<br>TWE: AC 794<br>ITI 795<br>CFU 797 |

## Codes Used for TWE Pages

| | |
|---|---|
| A | Assessment |
| AC | Across the Curriculum |
| ACT | Activity |
| AES | Applying Earth Science |
| CB | Content Background |
| CD | Cultural Diversity |
| CFU | Check for Understanding |
| CL | Collaborative Learning |
| CON | Concept Development |
| D | Demo |
| DI | Differentiated Instruction |
| DIS | Discussion |
| E | Enrichment |
| EC | Environmental Connection |
| ESJ | Earth Science Journal |
| IM | Identifying Misconceptions |
| ITI | Interpreting the Illustration |
| M | Modeling |
| P | Project |
| R | Reteach |
| RE | Reinforcement |
| TL | Time Line |
| TPK | Tying to Previous Knowledge |
| UAA | Using an Analogy |
| UST | Using Science Terms |