MICHIGAN
Science Content Standards and Working Draft Benchmarks
Middle School
Science Level Blue © 2005

STANDARDS	PAGE REFERENCES
I. Construct New Scientific and Personal Knowledge	
Content Standard 1: All students will ask questions that help them learn about the world; design and conduct investigations using appropriate methodology and technology; learn from books and other sources of information; communicate their findings using appropriate technology; and reconstruct previously learned knowledge. (Constructing New Scientific Knowledge)	
1. Generate scientific questions about the world based on observation. (*Key concepts:* See Using Scientific Knowledge. *Real-world contexts:*)	SE: 6-11, 13-23, 724-732 *Lab* 12, 28-29, 72, 82-83, 326-327 *Applying Science* 14, 372 *National Geographic* 20 *MiniLAB* 99, 554 *Launch LAB* 149 TWE: TPK 13
2. Design and conduct simple investigations. (*Key concepts:* The process of scientific investigations-test, fair test, hypothesis, data, conclusion. Forms for recording and reporting data-tables, graphs, journals. *Real-world contexts:* See Using Scientific Knowledge.)	SE: 8-11, 14-19, 21-23, 724-732, 750, 765-766 *MiniLAB* 9 *National Geographic* 20 TWE: UA 8 USW 10, 16 FYI 10, 14 AC 15 VL 17 VIL 17
3. Investigate toys/simple appliances and explain how they work, using instructions and appropriate safety precautions. (*Key concepts:* Safety precautions for using electrical appliances. Documentation for toys and appliances-diagrams, written instructions. *Real-world contexts:* Situations requiring assembly, use, or repair of toys, radios, or simple appliances, such as replacing batteries; connecting electrical appliances, such as stereos, videocassette recorders.)	SE: 24-27, 531, 533, 538, 550, 552, 555, 558, 560, 645 *Lab* 539, 684-685 *Accidents in Science* 542 *National Geographic* 564 *MiniLAB* 644, 674 TWE: TPK 24, 666 AC 26 WQ 518 AP 520 LD 536 IH 582

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4. Use measurement devices to provide consistency in an investigation. (*Key concepts:* Documentation-laboratory instructions. Measurement units-milliliters, liters, teaspoon, tablespoon, ounce, cup, millimeter, centimeter, meter, gram, nonstandard units. *Measurement tools:* Balancing devices, measuring cups and spoons, measuring tape. *Real-world contexts:* Cooking for groups of various sizes; following or altering laboratory instructions for mixing chemicals.)	SE: 10, 17, 567, 608-610, 729-730, 753 *Launch LAB* 5 *Lab* 392-393 *MiniLAB* 567 TWE: QD 17 LD 567 TPK 608 DIN 609 USW 610
5. Use sources of information to help solve problems. (*Tools:* Forms for presenting scientific information, such as figures, tables, graphs. *Real-world contexts:* Libraries, projects where research is needed.)	SE: 7, 13, 17-18, 526, 532 *Applying Science* 14 TWE: DI 8 VL 17 CC 526 AC 526 DLV 527, 532
6. Write and follow procedures in the form of step-by-step instructions, recipes, formulas, flow diagrams, and sketches. (*Key concepts:* Purpose, procedure, observation, conclusion. *Real-world contexts:* Following a recipe; listing or creating the directions for completing a task.)	SE: 21-23, 724-732 *National Geographic* 20 *Lab: Design Your Own* 82-83, 112-113, 424-425, 510-511, 598-599, 624-625 TWE: FYI 21 AC 21, 22 DLV 23 AIL 598
II. Reflect on the Nature, Adequacy and Connections Across Scientific Knowledge	
Content Standard 1: All students will analyze claims for their scientific merit and explain how scientists decide what constitutes scientific knowledge; how science is related to other ways of knowing; how science and technology affect our society; and how people of diverse cultures have contributed to and influenced developments in science. (Reflecting on Scientific Knowledge)	
1. Evaluate the strengths and weaknesses of claims, arguments, or data. (*Key concepts:* Aspects of arguments such as data, evidence, sampling, alternate explanation, conclusion. *Real-world contexts:* Deciding between alternate explanations or plans for solving problems; evaluating advertising claims or cases made by interest groups.)	SE: 8-11 *MiniLAB* 18 TWE: ISS 7 DIN 8 FYI 10 AS 11 AC 15
2. Describe limitations in personal knowledge. (*Key concepts:* Recognizing degrees of confidence in ideas or knowledge from different sources. *Real-world contexts:* See Using Scientific Knowledge.)	SE: 8, 22-23 TWE: AC 15

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3. Show how common themes of science, mathematics, and technology apply in real-world contexts. (*Thematic ideas:* Systems-subsystems, feedback models, mathematical constancy, scale, conservation, structure, function, adaptation. *Real-world contexts:* See Using Scientific Knowledge.)	SE: 71, 73-81 TWE: AS 71 DLV 71 TPK 73 IH 75 QD 78 FYI 79, 80
4. Describe the advantages and risks of new technologies. (*Key concepts:* Risk, benefit, side effect, advantage, disadvantage. *Real-world contexts:* Technological systems for manufacturing, transportation, energy distribution, housing.)	SE: *Accidents in Science* 264, 362, 542, 716 TWE: IH 452, 703
5. Recognize the contributions made in science by cultures and individuals of diverse backgrounds. (*Key concepts:* Scientific contributions made by people of diverse cultures and backgrounds. *Real-world contexts:* See Using Scientific Knowledge.)	TWE: CD 10, 40, 65, 95, 126, 155, 195, 222, 246, 276, 307, 350, 387, 406, 443, 473, 506, 523, 565, 593, 622, 637, 677, 698 FYI 588
III. Use Scientific Knowledge from the Life Sciences in Real-World Contexts	
Content Standard 1: All students will apply an understanding of cells to the functioning of multicellular organisms; and explain how cells grow, develop and reproduce. (Cells)	
1. Describe similarities/differences between single-celled and multicellular organisms. (*Key concepts:* Differences-single-celled, multicellular, cell specialization. Cell structures-nucleus, cytoplasm, cell wall, cell membrane. *Observation tools*: Hand lens, microscope. *Real-world contexts:* Common examples of protists: Amoeba, Paramecium; common examples of specialized cells of multicellular organisms-leaf cells, root cells, stem cells, blood cells, muscle cells, nerve cells.)	SE: 68-72, 73-75 *National Geographic* 69, 638 *Lab* 72 Simple organisms are discussed in Chapter 10 Section 2.
2. Explain why specialized cells are needed by plants and animals. (*Key concepts:* Specialized functions of cells – reproduction, photosynthesis, transport. *Real-world contexts:* Specialized animal cells: red blood cells, white blood cells specialized plant cells – root cells, leaf cells, stem cells.)	SE: 68-71, 73-75, 637, 713 *National Geographic* 69, 638 *Lab* 72 TWE: DIN 69 UA 70 AS 72 TPK 73 IL 638

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3. Explain how cells use food as a source of energy. (*Key concepts:* How cells use food-food, molecule, respiration, oxygen, carbon dioxide, water. *Real-world contexts:* Experiments/ demonstrations showing reactants/products of respiration and photosynthesis.)	SE: 64-66, 68-71, 73-78, 123, 135 *MiniLAB* 74, 76 *Lab* 82-83 *National Geographic* 134 TWE: AC 66 IL 68 LD 70 FF 77 QD 123 RC 135
Content Standard 2: All students will use classification systems to describe groups of living things; compare and contrast differences in the life cycles of living things; investigate and explain how living things obtain and use energy; and analyze how parts of living things are adapted to carry out specific functions. (Organization of Living Things)	
1. Compare and classify organisms into major groups on the basis of their structure. (*Key concepts:* Characteristics used for classification- vertebrates/invertebrates, cold-blooded/warm-blooded, single-cell/multicellular, flowering/nonflowering. *Real-world contexts:* Representative organisms, such as dog, worm, snake, Amoeba, geranium, wheat.)	SE: 49-53, 273-274, 276, 290 *National Geographic* 51 *Lab* 287 TWE: TPK 49 DI 275, 276 AC 276
2. Describe the life cycle of a flowering plant. (*Key concepts:* Flowering plant parts and processes-roots, stems, leaves, flowers, fruits, seeds, embryo, pollen, ovary, egg cell, germination, fertilization. *Real-world contexts:* Common flowering plants, such as bean, tulip.)	SE: 290 Also see Glencoe's *Life Science* © 2005.
3. Describe evidence that plants make and store food. (*Key concepts:* Process and products of food production-photosynthesis, starch, sugar, oxygen. *Real-world contexts:* Plant food storage organs, such as potato, onion; starch storage in plants grown under different conditions.)	SE: 40-41, 106-107, 122-124, 136 *MiniLAB* 40 *Launch LAB* 149
4. Explain how selected systems and processes work together in plants and animals. (*Key concepts:* Systems/Processes-digestion, circulation, respiration, endocrine, reproduction, skeletal, muscular, nervous, excretion, transport, growth, repair. *Real-world contexts:* Interrelations of body systems during selected activities, such as among skeletal, muscular, circulatory, and respiratory systems during physical exercise.)	SE: 64, 70-71, 73-81 *Lab* 72, 82-83 *Science Stats* 84 TWE: VL 70 AS 71, 81 TPK 73 FYI 75, 79 AC 80

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Content Standard 3: All students will investigate and explain how characteristics of living things are passed on through generations; explain why organisms within a species are different from one another; and explain how new traits can be established by changing or manipulating genes. (Heredity)	
1. Describe how the characteristics of living things are passed on through generations. (*Key concepts:* Reproductive cells-egg, sperm. Cell parts-nucleus, gene. *Real-world contexts:* Common traits controlled by a single gene pair, such as wrinkled or smooth seeds in a pea plant, color of horse hair.)	SE: 68, 71, 38-42, 44-48 *Launch LAB* 37 *Integrate Chemistry* 39 *Lab* 43 *Applying Math* 47 TWE: SCB 36E DIN 39, 48 FYI 39 SJ 46 DLV 48 AS 71
2. Describe how heredity and environment may influence/determine characteristics of an organism. (*Key concepts:* Traits-inherited, acquired. *Real-world contexts:* Data on heredity, such as identical twin studies, effects of introduced toxins, effects of natural selection, effects of controlled selection and breeding.)	SE: 44-48, 49-53 *MiniLAB* 46 *Applying Math* 47 *Lab* 54-55 *Science and Society* 56 TWE: SCB 36E TPK 44 FYI 47
Content Standard 4: All students will explain how scientists construct and scientifically test theories concerning the origin of life and evolution of species; compare ways that living organisms are adapted (suited) to survive and reproduce in their environments; and analyze how species change through time. (Evolution)	
1. Describe how scientific theory traces possible evolutionary relationships among present and past life forms. (*Key concepts:* Selected evidence of common ancestry-geologic time, fossil, bone, embryo, limb. *Real-world contexts:* A-V media, models of fossils that show evidence of common ancestry, such as similarity of vertebrate limb bones, similarity of early vertebrate embryos, similarity of fossil bones to those of contemporary animals i.e., horse legs.)	SE: 183-184, 240-249, 272-278, 289-290 *MiniLAB* 184 TWE: SCB 240E FF 245 DI 246 MM 247, 275 SJ 247 DI 277, 289

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Content Standard 5: All students will explain how parts of an ecosystem are related and how they interact; explain how energy is distributed to living things in an ecosystem; investigate and explain how communities of living things change over a period of time; describe how materials cycle through an ecosystem and get reused in the environment; and analyze how humans and the environment interact. (Ecosystems)	
1. Describe common patterns of relationships among populations. (*Key concepts:* Participants and relationships-predator, prey, parasitism, competition, symbiosis. *Real-world contexts:* Examples of predator-prey, symbiotic, and parasitic relationships-see elementary benchmarks 1 and 2; examples of competitive relationships, including squirrels and seed-eating birds, cattle and bison.)	SE: 50, 94-101, 107-110 *Lab* 43 *Reading Check* 50 *MiniLAB* 99 *Applying Science* 101 TWE: TPK 98 AC 101, 108 DIN 108 DLV 110
2. Predict the effects of changes in one population in a food web on other populations. (*Key concepts:* Natural balance, population, dependence, survival. *Real-world contexts:* Plants and animals in an ecosystem dependent upon each other for survival in selected ecosystems-see elementary benchmark 3; comparison of animals and plants found in polluted vs. nonpolluted water, urban vs. rural settings, rural vs. forest settings.)	SE: 98-102, 106-108, 137-139 TWE: TPK 98, 106 IL 100 AC 101 MM 108 DLV 110, 139 DIN 137 VL 138
3. Describe how all organisms in an ecosystem acquire energy directly or indirectly from sunlight. (*Key concepts:* Sunlight, plants, food, photosynthesis, heat. *Real-world contexts:* Selected food chains, including humans; also see Cells benchmarks related to photosynthesis.)	SE: 106, 123-125, 136-139, 710 TWE: FF 108 MM 108 SCB 120F DIN 137 FYI 138 AIL 140
4. Describe the likely succession of a given ecosystem over time. (*Key concepts:* Succession, stages, climax community. *Real-world contexts:* Process of gradual change in ecological systems, such as in ponds or abandoned farm fields.)	SE: 150-153, 154 *National Geographic* 152 TWE: FYI 151 DLV 153 AS 153
5. Identify some common materials that cycle through the environment. (*Key concepts:* Carbon cycle and water cycle-water, carbon dioxide, oxygen, sugar (food). Also see appropriate Cells and Atmosphere and Weather benchmarks. *Real-world contexts:* Selected ecosystems-also see elementary benchmark 3.)	SE: 127, 130-135 *Integrate Earth Science* 128 *Reading Check* 132 *MiniLAB* 133 *National Geographic* 134 TWE: SJ 131 VL 131 DLV 135

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6. Describe ways in which humans alter the environment. (*Key concepts:* Agriculture, land use, resource development, resource use, solid waste, toxic waste. *Real-world contexts:* Human activities, such as farming, pollution from manufacturing and other sources, hunting, habitat destruction, land development.)	SE: 133, 135, 161, 164-165, 167, 423, 617 *Integrate Career* 127, 165 *MiniLAB* 133 *Lab* 170-171 TWE: DIN 132, 135 FYI 165
7. Explain how humans use and benefit from plant and animal materials. (*Key concepts:* Materials from plants, including-wood, paper, cotton, linen, starch, rubber, wax, and oils. Materials from animals, including leather, wool, fur, protein, oils, wax. *Real-world contexts:* Human-made objects that incorporate plant and animal materials, including clothing, building materials, machines, and medicines-also see elementary benchmark 1, and middle school benchmarks 3 and 6-also see appropriate Geosphere benchmarks.)	SE: 66-67, 73-76, 136-139 TWE: SCB 62F SJ 66 FYI 75
IV. Use Scientific Knowledge from the Physical Sciences in Real-World Contexts	
Content Standard 1: All students will measure and describe the things around us; explain what the world around us is made of; identify and describe forms of energy; and explain how electricity and magnetism interact with matter. (Matter and Energy)	
1. Measure physical properties of objects or substances (mass, weight, area, temperature, dimensions, volume). (*Key concepts:* Units of measure-kilogram, gram, liter, degrees Fahrenheit, degrees Celsius. *Measurement tools:* Balances, spring scales, measuring cups or graduated cylinders, thermometers, metric ruler. *Real-world contexts:* Common substances such as those listed in elementary benchmark 1; hot and cold substances, such as ice, snow, cold water, hot water, steam, cold air, hot air.)	SE: 17, 557, 609-610, 762-763, 768 *Applying Math* 77, 610 TWE: QD 17 DIN 609 FF 610
2. Describe when length, mass, weight, area, or volume are appropriate to describe the size of an object or the amount of a substance. (*Key concepts:* Length, mass, weight, area, volume. Array of measuring devices, metric ruler, graduated cylinders, balances, spring scale. *Real-world contexts:* Common objects-see elementary benchmark 1.)	SE: 13, 15, 17 *Lab* 12, 392-393, 624-625 TWE: QD 17 SJ 18

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3. Classify substances as elements, compounds, or mixtures. (*Key concepts:* Element, compound, mixture. *Real-world contexts:* Common substances such as those listed above, including-elements, such as copper, aluminum, sulfur, helium, iron; compounds, such as water, salt, sugar, carbon dioxide; mixtures, such as soil, salt and pepper, salt water.)	SE: 66-67, 405, 468, 473-475, 479 *Integrate Earth Science* 67 *Applying Science* 469 *Lab* 481, 482-483 *Glossary/Glosario* 775, 778 TWE: FYI 67 DI 477 USW 479
4. Describe matter as consisting of extremely small particles (atoms) which bond together to form molecules. (*Key concepts:* Molecule, particle, matter, bond, atom. *Real-world contexts:* Common substances such as those listed above.)	SE: 404-405, 408-412, 474-477 *MiniLAB* 475 TWE: TPK 404 UA 405, 476 IL 408 FYI 409 FF 469, 477
5. Describe the arrangement and motion of molecules in solids, liquids, and gases. (*Key concepts:* Arrangement-regular pattern, random. Distance between molecules-closely packed, separated. Molecular motion-vibrating, bumping together, moving freely. *Real-world contexts:* Common solids, liquids, and gases, such as those listed above.)	SE: 468-469, 472-480, 637-639 *Applying Science* 469 *National Geographic* 478 TWE: SJ 469 FYI 475
6. Describe energy and the many common forms it takes (mechanical, heat, light, sound, electrical, magnetic, chemical, nuclear). (*Key concepts:* Forms of energy-mechanical, heat, sound, light, electrical, magnetic, chemical, nuclear, food energy. *Real-world contexts:* Body heat, heating a home, using light to see, using sound to hear, eating food, using electricity for appliances, gasoline for cars, nuclear power.)	SE: 106-107, 124, 136-139, 381-382, 498-501, 619-620, 694 *Integrate Chemistry* 107 *Integrate Earth Science* 137 *Integrate Environment* 420 *National Geographic* 621 TWE: TPK 136 DIN 137 QD 138, 381 IM 498 DI 499
7. Describe how common forms of energy can be converted, one to another. (*Key concepts:* Forms of energy-mechanical, heat, sound, light, electrical, magnetic, chemical, nuclear, food energy. Conservation of energy. Energy transformation. *Real-world contexts:* Motors, generators, power plants, lightbulbs, appliances, cars, walking, playing a musical instrument, cooking food.)	SE: 136-137, 499, 619-623 *Integrate Environment* 420 *National Geographic* 621 TWE: DIN 137, 620 SJ 498, 620 TPK 619

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8. Describe electron flow in simple electrical circuits. (*Key concepts:* Complete circuit, open circuit, closed circuit. *Real-world contexts:* Household wiring, electrical conductivity testing, flashlight, electric appliances.)	SE: 643-647, 650-651 *MiniLAB* 650 *Lab* 655, 656-657 TWE: DIN 644 LD 645 UA 646 QD 651
9. Use electric currents to create magnetic fields. (*Key concepts:* Electric current, magnetic poles, magnetic fields. *Tools:* Magnetic compass, battery, wire. *Real-world contexts:* Electromagnets, bells, speakers, motors, magnetic switches, Earth's magnetic field.)	SE: 673-674 *MiniLAB* 674 *National Geographic* 675 *Lab* 684-685 TWE: TPK 673 FYI 676
Content Standard 2: All students will investigate, describe and analyze ways in which matter changes; describe how living things and human technology change matter and transform energy; explain how visible changes in matter are related to atoms and molecules; and how changes in matter are related to changes in energy. (Changes in Matter)	
1. Describe common physical changes in materials: evaporation, condensation, thermal expansion, and contraction. (*Key concepts:* States of matter-solid, liquid, gas. Changes in states of matter-evaporation, condensation. Thermal expansion and contraction. *Real-world contexts:* States of matter-solid, liquid, gas. Changes in state, such as water evaporating as clothes dry, condensation on cold window panes; expansion of bridges in hot weather.)	SE: 130-131, 492, 609 *Lab* 509 TWE: IM 131 QD 131
2. Describe common chemical changes in terms of properties of reactants and products. (*Key concepts:* Common chemical changes-burning paper, rusting iron, formation of sugars during photosynthesis. *Real-world contexts:* Chemical changes-burning, photosynthesis, digestion, corrosion.)	SE: 492-494, 499-500, 506 *Launch LAB* 491 *National Geographic* 493 *Integrate Life Science* 495 *MiniLAB* 496 *Lab* 509 TWE: SCB 490E IM 490F
3. Distinguish between physical and chemical changes in natural and technological systems. (*Key concepts:* Changes in matter-physical changes and chemical changes. *Real-world contexts:* Natural physical and chemical changes-water cycle, chewing, erosion, corrosion, photosynthesis, respiration; technological physical and chemical changes-dehydrated foods, solid air fresheners, recycling glass, burning fuels, manufacturing plastics.)	SE: 492, 637 *Launch LAB* 491 *National Geographic* 493 *Integrate Life Science* 495 *Lab* 509

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4. Describe how waste products accumulating from natural and technological activity create pollution. (*Key concepts:* Manufacturing, distribution, refining, mining, landfill, water treatment. *Real-world contexts:* Many sources of pollution, both natural and technological.)	SE: 163-165, 617 *Integrate Career* 165 *Science and Society* 172 TWE: FYI 165
5. Explain physical changes in terms of the arrangement and motion of atoms and molecules. (*Key concepts:* Molecular descriptions of states of matter-also see Matter and Energy benchmarks. Physical changes-States of matter (solid, liquid, gas). Changes in size and shape-bending, tearing, breaking. Changes in state of matter-melting, freezing, evaporation, condensation. Thermal expansion and contraction. Speed of molecular motion-moving faster, slower, vibrate, rotate, unrestricted motion, conservation of matter. *Real-world contexts:* See examples of Physical Changes of Matter, elementary benchmark 1 and middle school benchmark 3.)	SE: 130-135, 608-611 *Launch LAB* 607 *MiniLAB* 614 TWE: SCB 606E-F FYI 610
Content Standard 3: All students will describe how things around us move and explain why things move as they do; demonstrate and explain how we control the motions of objects; and relate motion to energy and energy conversions. (Motion of Objects)	
1. Qualitatively describe and compare motions in three dimensions. (*Key concepts:* Three-dimensional motion-up, down, curved path. *Real-world contexts:* Objects moving in three dimensions, such as thrown balls, roller coasters, cars on hills, airplanes.)	SE: 522-526, 529, 532, 560-562 *Launch LAB* 521 *MiniLAB* 525 *Applying Math* 532 TWE: SCB 520E IM 520F AP 520 QD 523, 529 VIL 525 FYI 559
2. Relate changes in speed or direction to unbalanced forces in two dimensions. (*Key concepts:* Changes in motion and common forces-speeding up, slowing down, turning, push, pull, friction, gravity. Additional forces-attraction, repulsion, balanced, unbalanced. *Real-world contexts:* Changing the direction-changing the direction of a billiard ball, bus turning a corner; changing the speed-car speeding up, a rolling ball slowing down, magnets, other common objects that are and are not attracted to magnets.)	SE: 527-529, 550-560, 581, 588 TWE: DLV 527, 555 QD 529, 552 USW 551 FYI 559

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3. Describe the forces exerted by magnets, electrically charged objects, and gravity. (*Key concepts:* Electrical charges and magnetic poles-north pole, south pole, positive charge, negative charge, weight, gravitational pull. *Real-world contexts:* Electrically charged or polarized objects, such as balloons rubbed on clothing, bits of paper, salt grains, magnets, magnetic materials, earth's gravitational pull on objects.)	SE: 187-188, 307-308, 636-641, 666-671 *MiniLAB* 308 *Launch LAB* 635 *Lab* 672, 747 TWE: CD 637 QD 637, 639
4. Design strategies for moving objects by application of forces, including the use of simple machines. (*Key concepts:* Types of simple machines-lever, pulley, screw, inclined plane, wedge, wheel, and axle. *Real-world contexts:* Objects being moved by using simple machines, such as wagons on inclined planes, heavy objects moved by levers, seesaw, cutting with knives or axes.)	SE: 580-584, 586-597 *Launch LAB* 579 *Lab* 585, 598-599, 745 *Applying Math* 587, 589 *National Geographic* 595 *MiniLAB* 596 *Science and Society* 600 TWE: FF 588, 595 SJ 592 AC 593 LD 594
Content Standard 4: All students will describe sounds and sound waves; explain shadows, color, and other light phenomena; measure and describe vibrations and waves; and explain how waves and vibrations transfer energy. (Waves and Vibrations)	
1. Explain how sound travels through different media. (*Key concepts:* Media-solids, liquids, gases. *Real-world contexts:* Sounds traveling through solids, such as glass windows, strings, the earth; sound traveling through liquids, such as dolphin and whale communication; sound traveling through gases, such as human hearing, sonic booms.)	SE: 694, 701-705 *Lab* 706 TWE: IL 702 DI 704
2. Explain how echoes occur and how they are used. (*Key concepts:* Echo, sonar. *Real-world contexts:* Echoes in rooms-acoustics-and outdoors; practical uses of echoes, such as navigation by bats and dolphins, ultrasound imaging, sonar.)	SE: 705 TWE: FYI 187
3. Explain how light helps us to see. (*Key concepts:* Light source, illumination, path of light, reflection, absorption. Parts of eye-retina, vitreous humor, lens, cornea, pupil, iris, optic nerve. *Real-world contexts:* Seeing common objects in our environment; seeing "through" transparent media, such as windows, water.)	SE: 709-713 *MiniLAB* 710 *National Geographic* 712 TWE: QD 711 AC 711, 713 DLV 713

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4. Explain how objects or media reflect, refract, transmit, or absorb light. (*Key concepts:* Reflection, refraction, absorption, transmission, scattering (or diffusion), medium. Transmission of light-transparent, translucent, opaque. Refraction of light-lenses, prisms. *Real-world contexts:* Objects that reflect or absorb light, with and without scattering, such as ordinary light and dark colored metals, mirrors; media that transmit light with and without scattering, such as clear and frosted glass, clear and cloudy water, clear and smoky air; uses of lenses, such as eye, cameras, telescope, microscope, magnifying lens.)	SE: 699, 709 *MiniLAB* 699 *Lab* 714-715 TWE: QD 711 AIL 714
5. Describe the motion of pendulums or vibrating objects (frequency, amplitude). (*Key concepts:* Period, frequency, amplitude. *Real-world contexts:* Vibrating or oscillating objects, such as pendulums, weights on springs, vocal cords, tuning forks, guitar strings.)	SE: 696-698, 702-703 TWE: FYI 696 AC 696 QD 697, 703 LD 703
6. Explain how waves transmit energy. (*Key concepts:* Types and forms of energy, longitudinal, transverse, emission, absorption, transmission, reflection. *Real-world contexts:* Reflecting and nonreflecting objects such as mirrors, black cloth, waves in slinkies and long springs, water waves.)	SE: 694-698 TWE: SCB 692E UA 697 IM 698
V. Use Scientific Knowledge from the Earth and Space Sciences in Real-World Contexts	
Content Standard 1: All students will describe the earth's surface; describe and explain how the earth's features change over time; and analyze effects of technology on the earth's surface and resources. (Geosphere)	
1. Describe and identify surface features using maps. (*Key concepts:* Types of maps-relief, topographic, elevation. Landforms-plains, deserts, plateaus, basin, Great Lakes, rivers, continental divide, mountains, mountain range, or mountain chain. *Real-world contexts:* Maps showing regional surface features, such as the Great Lakes or local topography.)	SE: 324-325, 527, 767
2. Explain how rocks and minerals are formed. (*Key concepts:* Processes of forming rocks-melting, cooling, heat, pressure, sediments. Heat source is interior of earth-see Solar System benchmarks. Materials-soil, sand, rock, lava, shells, dead organisms. *Real-world contexts:* Physical environments where rocks are being formed, such as volcanoes-by cooling, ocean floor-by deposition, deltas, beaches, swamps.)	SE: 280 *Integrate Earth Science* 202 *Reading Check* 260

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3. Explain how rocks and fossils are used to determine the age and geological history of the earth. (*Key concepts:* Time lines, rock layers, fossils, relative dating. See Waves and Vibrations benchmarks. *Real-world contexts:* Places where rock layers are visible; fossils, such as Petoskey stones.)	SE: 250-255, 257-261 *Lab* 256 TWE: QD 251 IL 254 AC 259
4. Explain how rocks are broken down, how soil is formed and how surface features change. (*Key concepts:* Forces-gravity, pressure. Erosion by-glaciers, waves, wind, streams, weathering, plant roots. Decomposition by-bacteria, fungi, worms, rodents, other animals. See Ecosystems benchmarks. *Real-world contexts:* Local areas where erosion by wind, water, or glaciers may have occurred, such as along the shoulder of roads, under downspouts; chemical weathering from road salt, formation of caverns; physical weathering, such as potholes and cracks in sidewalks from frozen water.)	SE: 150-151 *MiniLAB* 124 *Lab* 129 TWE: QD 151
5. Explain how technology changes the surface of the earth. (*Key concepts:* Types of human activities-surface mining, construction and urban development, farming, dams, landfills, restoring marsh lands, reclaiming spoiled land. *Real-world contexts:* Local example of surface changes due to human activities listed in the Key concepts above; local examples of negative consequences of these changes, such as groundwater pollution, destruction of habitat and scenic land, reduction of arable land.)	SE: 165, 617 *Science and Society* 172 TWE: DI 25
Content Standard 2: All students will demonstrate where water is found on earth; describe the characteristics of water and how water moves; and analyze the interaction of human activities with the hydrosphere. (Hydrosphere)	
1. Describe various forms that water takes on the earth's surface and conditions under which they exist. (*Key concepts:* Liquid water forms-lakes, rivers, oceans, springs. Frozen water forms-continental glacier, valley glacier, snow on mountains, polar cap. Gaseous water in atmosphere. Climate changes, ice ages. Also see Atmosphere and Weather benchmarks. *Real-world contexts:* Local lakes, rivers, streams, ponds, springs; examples of frozen water, including snow, glaciers, icebergs, polar regions, frozen Great Lakes shorelines.)	SE: 94, 123, 128, 130-131 *Science Stats* 142 TWE: QD 95, 127 FF 95 DIN 123 IL 125 SJ 131 IM 131

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2. Describe how rain water in Michigan reaches the oceans. (*Key concepts:* Water path-run-off, creeks, streams, wetlands, rivers, Great Lakes. See elementary benchmark 2 and Atmosphere and Weather benchmarks. Motion of water-currents, waves, tides. Temperature, thermal layering. Ocean composition-saltiness. *Real-world contexts:* Maps showing streams, lakes, rivers, oceans; examples of motions of rivers and lakes; investigations of rivers and lake temperatures.)	SE: 163-169 *Lab* 170-171 *Science and Society* 172 TWE: TPK 163 FYI 165 MM 166
3. Describe the origins of pollution in the hydrosphere. (*Key concepts:* Sources of pollution-sewage, household dumping, industrial wastes. Limits to natural resources. Also see Geosphere benchmarks and Atmosphere and Weather benchmarks. *Real-world contexts:* Examples of polluted water; examples of occasions when water supply is restricted, such as during droughts.)	SE: 164-165 *Integrate Career* 165 TWE: FYI 165
Content Standard 3: All students will investigate and describe what makes up weather and how it changes from day to day, from season to season and over long periods of time; explain what causes different kinds of weather; and analyze the relationships between human activities and the atmosphere. (Atmosphere and Weather)	
1. Describe the composition and characteristics of the atmosphere. (*Key concepts:* Atmosphere-air, molecules, gas, water vapor, humidity, dust particles, air pressure. Temperature changes with altitude. Also see Hydrosphere benchmarks. *Real-world contexts:* Examples of characteristics of the atmosphere, including steam, pressurized cabins in airplanes, demonstrations of air pressure; examples of air-borne particulates, such as smoke, dust, pollen, bacteria.)	SE: 122-123, 126-127, 132-133, 281 *Applying Math* 126 *National Geographic* 134 *Integrate Chemistry* 281 TWE: QD 123 IL 125 FYI 126 DIN 127
2. Describe patterns of changing weather and how they are measured. (*Key concepts:* Weather patterns-cold front, warm front, air mass. *Tools:* Thermometer, rain gauge, wind direction indicator, weather maps, satellite weather images. *Real-world contexts:* Sudden temperature and cloud formation changes; records, charts, and graphs of weather changes over periods of days.)	SE: 123-128 *Applying Math* 126 *Integrate Career* 127 TWE: DIN 125 QD 127 DI 127

STANDARDS	PAGE REFERENCES
3. Explain the water cycle and its relationship to weather patterns. (*Key concepts:* Water cycle-evaporation, condensation, cooling, clouds, run-off. Precipitation-rain, snow, hail, fog, humidity, droughts. Also see Changes in Matter benchmarks, Ecosystems benchmarks. *Real-world contexts:* Aspects of the water cycle in weather, including clouds, precipitation, evaporating puddles.)	SE: 123-126, 128, 130-131 TWE: IL 125 QD 127, 131 FYI 131 IM 131
4. Describe health effects of polluted air. (*Key concepts:* Effects-breathing difficulties, irritated eyes. Sources-car exhaust, industrial emissions. See Reflecting on Scientific Knowledge benchmarks. *Real-world contexts:* Locations and times where air quality is poor; local sources of potential air pollution.)	Pollution is discussed on SE: 165, 172 Respiration is discussed on SE: 71, 76
Content Standard 4: All students will compare and contrast our planet and sun to other planets and star systems; describe and explain how objects in the solar system move; explain scientific theories as to the origin of the solar system; and explain how we learn about the universe. (Solar System, Galaxy and Universe)	
1. Compare the earth to other planets in terms of supporting life. (*Key concepts:* Comparisons-relative distances, relative sizes, atmospheres, heat, temperature of planets. Compositions-rocky, solid, gases, frozen gases. Sun produces the light and heat that falls on each planet. Molecules necessary to support life-see Cells and Living Things benchmarks. *Real-world contexts:* Examples of local and extreme outdoor conditions on earth vs. conditions on other planets; situations where a heat source warms an object at varying distances from it.)	SE: 342-355 *Reading Check* 352 TWE: FYI 343, 355 IL 346 AS 347 SJ 355
2. Describe, compare, and explain the motions of planets, moons, and comets in the solar system. (*Key concepts:* Orbit, year, spin, axis, gravity, moons, rings, comets. Also see Motion of Objects benchmarks. *Real-world contexts:* Maps showing the motions of the planets, comets, moon and its phases.)	SE: 307, 309-316, 336-337 *Integrate Life Science* 307 *Lab* 321, 341 *Integrate Physics* 338, 340 *National Geographic* 339 TWE: TPK 336 DI 357
3. Describe and explain common observations of the day and night skies. (*Key concepts:* Perceived and actual movement of the moon across sky, moon phases, stars and constellations, planets, Milky Way, comet tail. *Real-world contexts:* Outdoor observing of the skies, using telescopes and binoculars, as well as "naked-eye" viewing; telescopic and spacecraft-based photos of planets, moons, and comets; news reports of planetary and lunar exploration.)	SE: 310-316, 356, 368, 370-374, 386-387 *MiniLAB* 371 TWE: DIN 311 QD 315, 372 DI 316, 357 AC 357, 373 TPK 370, 386 FYI 371

STANDARDS	PAGE REFERENCES
4. Explain current scientific thinking about how the solar system formed. (*Key concepts:* Clouds of gasses and dust, gravity, spinning, heavy and light elements, hot interiors of earth-like planets. Relative ages of the universe and solar system. *Tools:* Telescopes, binoculars. Also see Geosphere benchmarks. *Real-world contexts:* Telescope observing and photos of star-forming regions; drawings and narratives about star explosions and star formation; accounts of searches for other planets around neighboring stars.)	SE: 338, 388-391 *National Geographic* 339, 390

Codes Used for TWE Pages

AC	Activity
AIL	Alternative Inquiry Lab
AP	About the Photo
AS	Assessment
CC	Curriculum Connection
CD	Cultural Diversity
DI	Discussion
DIN	Differentiated Instruction
DLV	Daily Intervention
FF	Fun Fact
FYI	Teacher FYI
IH	Integrate History
IL	Inquiry Lab
IM	Identifying Misconceptions
ISS	Integrate Social Studies
LD	Lab Demonstration
MM	Make a Model
QD	Quick Demo
RC	Reading Check
SCB	Science Content Background
SJ	Science Journal
TPK	Tie to Prior Knowledge
UA	Use an Analogy
USW	Use Science Words
VIL	Virtual Labs
VL	Visual Learning
WQ	Web Quest