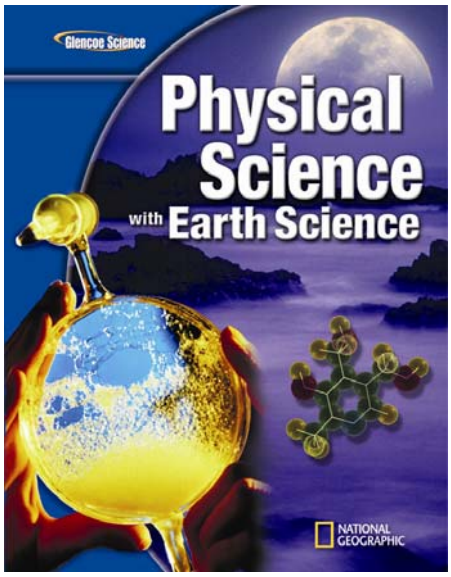
Science Academic Content Standards
Grade Nine

Ohio



Physical Science
with Earth Science

STANDARDS	PAGE REFERENCES
Earth and Space Sciences	
The Universe	
1. Describe that stars produce energy from nuclear reactions and that processes in stars have led to the formation of all elements beyond hydrogen and helium.	**Student Edition:** 803 *Figure 18* 803 *How Do Stars Change?* 824-825 *Integrate Astronomy* 596 *The Sun-A Main Sequence Star* 827 **Teacher Wraparound Edition:** D 825
2. Describe the current scientific evidence that supports the theory of the explosive expansion of the universe, the Big Bang, over 10 billion years ago.	**Student Edition:** 221 *Figure 4* 221 *Figure 21* 836 *Integrate Language Arts* 837 *The Big Bang Theory* 837 **Teacher Wraparound Edition:** RP 836; RS 837

Codes used for Teacher Wraparound Edition (TWE) pages are the initial caps of TWE headings on that page.

STANDARDS	PAGE REFERENCES
3. Explain that gravitational forces govern the characteristics and movement patterns of the planets, comets and asteroids in the solar system.	**Student Edition:** 111 *Comets and Other Objects* 236 *Figure 8* 105 *Figure 16* 111 *Integrate Astronomy* 105 *The Law of Universal Gravitation* 105 **Teacher Wraparound Edition:** As 110; IA 105; PR 111
Earth Systems	
4. Explain the relationships of the oceans to the lithosphere and atmosphere (e.g., transfer of energy, ocean currents and landforms).	**Student Edition:** 291, 532 *Diffraction* 304 *Figure 18* 304 *Figure 19* 661 *Integrate Earth Science* 258 *National Geographic* 268 Wave Action *660-661* **Teacher Wraparound Edition:** AIL 278; IES 258; NG 268; RP 535; VL 661
Processes That Shape Earth	
5. Explain how the slow movement of material within Earth results from: a. thermal energy transfer (conduction and convection) from the deep interior; b. the action of gravitational forces on regions of different density.	**Student Edition:** *Composition of Earth's Layers* 372 *Figure 22* 372 *Origin of Magma* 373 **Teacher Wraparound Edition:** EI 352F; PR 372
6. Explain the results of plate tectonic activity (e.g., magma generation, igneous intrusion, metamorphism, volcanic action, earthquakes, faulting and folding).	**Student Edition:** 363, 376 *Figure 8* 359, 617 *Figure 9* 360 *Figure 24* 374 *Intrusive Igneous Rocks* 617-619 *Lab* 379 *Origin of Magma* 373-374 *Science Online* 359 *Theory of Plate Tectonics* 358-360 **Teacher Wraparound Edition:** As 361; CC 377; CU 378; CYD 379; PR 360; RS 376

STANDARDS	PAGE REFERENCES
7. Explain sea-floor spreading and continental drift using scientific evidence (e.g., fossil distributions, magnetic reversals and radiometric dating).	**Student Edition:** *Continental Drift* 354-356 *Figure 1* 354 *Figure 3* 355 *Figure 4 & 5* 356 *Launch Lab* 353 *Seafloor Spreading Hypothesis* 356-358 *Section 1 Review Summary* 361 **Teacher Wraparound Edition:** A 355; As 353; D 355; MM 355; PR 360; VL 356; UA 357
Historical Perspectives and Scientific Revolutions	
8. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., heliocentric theory and plate tectonics theory).	**Student Edition:** 358 *Continental Drift* 354-356 *Figure 1* 218 *Figure 2 & 3* 219 *Integrate* History 218 *Launch Lab* 353 *Models of the Solar System* 218-219 *National Geographic* 233 *Understanding the Solar System* 220-221 **Teacher Wraparound Edition:** As 353; D 355; IHi 219; NG 233; RP 218; VL 356
Physical Sciences	
Nature of Matter	
1. Recognize that all atoms of the same element contain the same number of protons, and elements with the same number of protons may or may not have the same mass. Those with different masses (different numbers of neutrons) are called isotopes.	**Student Edition:** 585, 789 *Figure 5* 789 *Figure 7* 587 *Isotopes* 586-587 **Teacher Wraparound Edition:** As 587; CU 587; MA 576E; PR 587; VL 586
2. Illustrate that atoms with the same number of positively charged protons and negatively charged electrons are electrically neutral.	**Student Edition:** *Figure 1* 392 *Positive and Negative Charge* 392 *Table 3* 585 **Teacher Wraparound Edition:** D 585

STANDARDS	PAGE REFERENCES
3. Describe radioactive substances as unstable nuclei that undergo random spontaneous nuclear decay emitting particles and/or high energy wavelike radiation.	**Student Edition:** 789, 791-793 *Figure 8* 792 *Figure 9* 793 *Integrate History* 790 *Lab* 808-809 *Mini Lab* 802 **Teacher Wraparound Edition:** As 795; D 793, 808; DI 586; IHi 790; RP 791
4. Show that when elements are listed in order according to the number of protons (called the atomic number), the repeating patterns of physical and chemical properties identify families of elements. Recognize that the periodic table was formed as a result of the repeating pattern of electron configurations.	**Student Edition:** 593-595 *Figure 13* 595 *Section 3 Review Summary* 596 *Table 5* 590-591 **Teacher Wraparound Edition:** A 594; PR 595; RP 588; UA 591; VL 590
5. Describe how ions are formed when an atom or a group of atoms acquire an unbalanced charge by gaining or losing one or more electrons.	**Student Edition:** 594, 695-696 *Atomic Stability* 690-691 *Figure 5* 691 *Figure 6* 692 *Figure 8* 695 *Figure 10* 696 *Figure 12* 594 **Teacher Wraparound Edition:** A 696; D 695, 696; DI 691; MM 691; TFYI 696; UA 594
6. Explain that the electric force between the nucleus and the electrons hold an atom together. Relate that on a larger scale, electric forces hold solid and liquid materials together (e.g., salt crystals and water).	**Student Edition:** 260-261, 394, 579, 695-697 *Figure 10* 696 *Figure 11* 697 *Science Online* 261 **Teacher Wraparound Edition:** TFYI 696

STANDARDS	PAGE REFERENCES
7. Show how atoms may be bonded together by losing, gaining or sharing electrons and that in a chemical reaction, the number, type of atoms and total mass must be the same before and after the reaction (e.g., writing correct chemical formulas and writing balanced chemical equations).	**Student Edition:** 694-697, 723 *Figure 5* 724 *Figure 10* 696 *Figure 11* 697 **Teacher Wraparound Edition:** As 725; D 695; DI 697; MM 691; QD 691; R 725; SCB 718E; VL 724
8. Demonstrate that the pH scale (0-14) is used to measure acidity and classify substances or solutions as acidic, basic, or neutral.	**Student Edition:** *Figure 19* 773 *Lab* 775 *pH of a Solution* 773 **Teacher Wraparound Edition:** A 773; As 775; DI 773; QD 773; SJ 773
9. Investigate the properties of pure substances and mixtures (e.g., density, conductivity, hardness, properties of alloys, superconductors and semiconductors).	**Student Edition:** 552, 554-558 *Integrate Earth Science* 558 *National Geographic* 553 **Teacher Wraparound Edition:** A 553; CU 558; D 556; DI 553; NG 553; R 558; UA 554; USW 394
10. Compare the conductivity of different materials and explain the role of electrons in the ability to conduct electricity.	**Student Edition:** 392-396 *Current & Voltage Difference* 400 *Figure 2* 393 *Figure 5* 394 *Mini Lab* 267 *National Geographic* 397 *Section 1 Review* 399 #3, #5 **Teacher Wraparound Edition:** As 267, 399; CU 399; D 394; DI 395; NG 397; USW 394

STANDARDS	PAGE REFERENCES
Nature of Energy	
11. Explain how thermal energy exists in the random motion and vibrations of atoms and molecules. Recognize that the higher the temperature, the greater the average atomic or molecular motion, and during changes of state the temperature remains constant.	**Student Edition:** *Changing States* 261-263 *Figure 2* 256 *Figure 9* 263 *Thermal Energy* 256 *Thermal Expansion* 264-265 *Section 2 Review* 265 #2 **Teacher Wraparound Edition:** PR 265; RS 263; TPK 260; VL 263
12. Explain how an object's kinetic energy depends on its mass and its speed ($KE=\frac{1}{2}mv^2$).	**Student Edition:** *Applying Math* 130 *Kinetic Energy* 130 *Section 1 Review* 133 #3, #4 **Teacher Wraparound Edition:** QD 130
13. Demonstrate that near Earth's surface an object's gravitational potential energy depends upon its weight (*mg* where *m* is the object's mass and *g* is the acceleration due to gravity) and height (*h*) above a reference surface (*PE=mgh*).	**Student Edition:** 132-133 *Applying Math* 132 **Teacher Wraparound Edition:** As 133; QD 132
14. Summarize how nuclear reactions convert a small amount of matter into a large amount of energy. (Fission involves the splitting of a large nucleus into smaller nuclei; fusion is the joining of two small nuclei into a larger nucleus at extremely high energies.)	**Student Edition:** 141 *Figure 12* 141 *Figure 16* 801 *Figure 18* 803 *Nuclear Fission* 801-802 *Nuclear Fusion* 803 **Teacher Wraparound Edition:** CU 143; TFYI 803; USW 803

STANDARDS	PAGE REFERENCES
15. Trace the transformations of energy within a system (e.g., chemical to electrical to mechanical) and recognize that energy is conserved. Show that these transformations involve the release of some thermal energy.	**Student Edition:** 141 *Changing Forms of Energy* 135-136 *Efficiency of Power Plants* 492 *Figure 6* 136 *Figure 8* 490-491 *Figure 12* 141 *Mini Lab* 140 *Section 2 Review* 143 *The Law of Conservation of Energy* 139-141 *Using Energy* 486 **Teacher Wraparound Edition:** AIL 144; As 140, 143, 145; D 492; PR 143; R 143; TPK 135; VL 136
16. Illustrate that chemical reactions are either endothermic or exothermic (e.g., cold packs, hot packs and the burning of fossil fuels).	**Student Edition:** *Endergonic Reactions* 735-736 *Exergonic Reactions* 736, 738 *Figure 3* 487 *Figure 17* 735 *Figure 18 & 19* 736 *Figure 21* 738 **Teacher Wraparound Edition:** A 735; As 738, 740; LD 736; TFYI 736; VL 736
17. Demonstrate that thermal energy can be transferred by conduction, convection or radiation (e.g., through materials by the collision of particles, moving air masses or across empty space by forms of electromagnetic radiation).	**Student Edition:** *Figure 13* 266 *Figure 14* 267 *Figure 16* 269 *Lab* 271, 278-279 *Mini Lab* 267 *National Geographic* 268 **Teacher Wraparound Edition:** As 270, 271, 279; CYD 271; PR 270; QD 268; RS 268; TPK 266; UA 267; VL 267

STANDARDS	PAGE REFERENCES
18. Demonstrate that electromagnetic radiation is a form of energy. Recognize that light acts as a wave. Show that visible light is a part of the electromagnetic spectrum (e.g., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays).	**Student Edition:** *A Range of Frequencies* 462 *Figure 7* 461 *Figure 8* 462 *Figure 9* 463 *Mini Lab* 463 *Section 2 Review* 467 *Visible Light* 465 *Waves & Particles* 460-461 **Teacher Wraparound Edition:** DI 463; LD 465; MM 463; QD 465; VL 463
19. Show how the properties of a wave depend on the properties of the medium through which it travels. Recognize that electromagnetic waves can be propagated without a medium.	**Student Edition:** 321 *Launch Lab* 287 *Table 1* 321 *Waves in Space* 456 **Teacher Wraparound Edition:** As 287; BI 286; DI 290, 303, 321; IM 286F; SCB 286E; TFYI 321
20. Describe how waves can superimpose on one another when propagated in the same medium. Analyze conditions in which waves can bend around corners, reflect off surfaces, are absorbed by materials they enter, and change direction and speed when entering a different material.	**Student Edition:** *Diffraction* 304-305 *Figure 18 & 19* 304 *Figure 20* 305 *Figure 21* 306 *Figure 22* 307 *Interference* 306-307 *Reflection* 301-302 *Refraction* 302-303 **Teacher Wraparound Edition:** AIL 310; DI 303; IL 306; MM 304; QD 304; SCB 286E; SJ 302

STANDARDS	PAGE REFERENCES
Forces and Motion	
21. Demonstrate that motion is a measurable quantity that depends on the observer's frame of reference and describe the object's motion in terms of position, velocity, acceleration and time.	**Student Edition:** *Figure 1* 70 *Figure 4* 73 *Figure 9* 79 *Integrate History* 77 *Launch Lab* 69 *National Geographic* 78 *Motion* 70-71 *Section 1 Review* 75 *Section 2 Review* 80 **Teacher Wraparound Edition:** As 69; CU 80; D 77; IL 85; NG 78; QD 79
22. Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it.	**Student Edition:** *Figure 3* 100 *Figure 12* 82 *Lab* 87 *Mini Lab* 99 **Teacher Wraparound Edition:** BI 96; IM 82; LD 102; MM 100; R 103; TPK 81; VL 82
23. Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. (F_{net} =ma. Note that weight is the gravitational force on a mass.)	**Student Edition:** *Design Your Own Lab* 88-89 *Figure 6* 103 *Lab* 87 *Science Online* 101 **Teacher Wraparound Edition:** As 87, 89; DI 116; QD 102
24. Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object.	**Student Edition:** *Figure 12* 82 *Figure 14* 84 *Science Journal* 96 **Teacher Wraparound Edition:** QD 82, 115; R 103; TPK 113; SJ 114; VL 82, 99, 114
25. Demonstrate the ways in which frictional forces constrain the motion of objects (e.g., a car traveling around a curve, a block on an inclined plane, a person running, an airplane in flight).	**Student Edition:** *Figure 14 & 15* 84 *Launch Lab* 97 *Mini Lab* 83 **Teacher Wraparound Edition:** As 83; CU 86; LD 83; R 86

STANDARDS	PAGE REFERENCES
Historical Perspectives and Scientific Revolutions	
26. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., atomic theory, quantum theory and Newtonian mechanics).	**Student Edition:** 581, 583 *Integrate Astronomy* 596 *Integrate History* 790 *National Geographic* 582 *Oops! Accidents in Science* 744 *Quarks: Even Smaller Particles* 579-580 *Science Online* 595 *Time Science & History* 810 **Teacher Wraparound Edition:** A 582; CB 312, 810; CU 583; D 579, 744; DI 457, 460; IHi 790; NG 582; SCB 576E-576F
27. Describe advances and issues in physical science that have important, long-lasting effects on science and society (e.g., atomic theory, quantum theory, Newtonian mechanics, nuclear energy, nanotechnology, plastics, ceramics and communication technology).	**Student Edition:** 436-437 *Applying Science* 499 *Integrate Career* 592 *Integrate Health* 804 *Integrate History* 273 *Integrate Life Science* 586 *National Geographic* 553, 582, 737, 805 *Organizing the Elements* 588-589 *Time Science & History* 312, 448 **Teacher Wraparound Edition:** CC 433, 435; DI 436, 553, 737; IHi 273; HS 312, 448; NG 553, 582; TFYI 295
Science and Technology	
Understanding Technology	
1. Describe means of comparing the benefits with the risks of technology and how science can inform public policy.	**Student Edition:** 806 *Applying Science* 49, 499 *Integrate Environment* 667 *Integrate Health* 465 *Integrate Social Studies* 497 *Science Online* 474 *Time Science & Society* 510 *Using Science-Technology* 13 **Teacher Wraparound Edition:** AE 60; As 806; CC 495; D 510; DI 498, 586; IE 667; IH 465; ISS 497; PR 806; SJ 464, 802

STANDARDS	PAGE REFERENCES
Abilities To Do Technological Design	
2. Identify a problem or need, propose designs and choose among alternative solutions for the problem.	**Student Edition:** *Communicating Your Data* 345 *Design* 178 *Design Your Own Lab* 344-345 *Lab* 58-59, 112, 508-509 **Teacher Wraparound Edition:** AIL 508; As 509; De 178
3. Explain why a design should be continually assessed and the ideas of the design should be tested, adapted and refined.	**Student Edition:** *Communicating Your Data* 59 **Teacher Wraparound Edition:** CYD 59
Scientific Inquiry	
Doing Scientific Inquiry	
1. Distinguish between observations and inferences given a scientific situation.	**Student Edition:** *Collect Data* 854-855 *Draw Conclusions* 858
2. Research and apply appropriate safety precautions when designing and conducting scientific investigations (e.g., OSHA, Material Safety Data Sheets [MSDS], eyewash, goggles and ventilation).	**Student Edition:** *Introduction to Science Safety* 860-861 *Safety Symbols* 859
3. Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts.	**Student Edition:** *Lab* 176-177, 710-711, 808-809, 840-841 *Mini Lab* 195, 200, 375, 525, 581, 802, 819 **Teacher Wraparound Edition:** A 138, 521; As 581; DI 377, 808; IL 521; MM 201, 530, 828
4. Decide what degree of precision based on the data is adequate and round off the results of calculator operations to the proper number of significant figures to reasonably reflect those of the inputs.	**Student Edition:** *Math Skills Handbook* 874

STANDARDS	PAGE REFERENCES
5. Develop oral and written presentations using clear language, accurate data, appropriate graphs, tables, maps and available technology.	**Student Edition:** *Applying Math* 24 *Communicating Your Data* 51, 177, 477 *Debate* 510 *Design* 178 *Lab* 27 **Teacher Wraparound Edition:** A 805; AIL 28, 278, 508; As 51, 509, 599; CC 377; CYD 51, 177, 477, 509, 599, 841; D 510; De 178; DI 368, 737; II 778; PR 26, 377, 724; RS 660; SJ 24
6. Draw logical conclusions based on scientific knowledge and evidence from investigations.	**Student Edition:** *Conclude and Apply* 89, 134, 230, 243, 445, 507, 541, 677, 743, 807, 830, 841 **Teacher Wraparound Edition:** AIL 278, 541; As 134, 830
Scientific Ways of Knowledge	
Nature of Science	
1. Comprehend that many scientific investigations require the contributions of women and men from different disciplines in and out of science. These people study different topics, use different techniques and have different standards of evidence but share a common purpose – to better understand a portion of our universe.	**Student Edition:** *Design Your Own Lab* 28-29 *Integrate Career* 472, 592 *Integrate History* 705 *National Geographic* 582 *Oops! Accidents in Science* 60, 210, 712, 744 *Research* 810 *Time Science & History* 120, 810 **Teacher Wraparound Edition:** A 582; AE 712; AIL 28; CB 60, 744, 810; CD 8; D 210; HS 120; IC 472, 592; IHi 705; R 810
2. Illustrate that the methods and procedures used to obtain evidence must be clearly reported to enhance opportunities for further investigations.	**Student Edition:** 10 *Science Skills Handbook* 858 **Teacher Wraparound Edition:** DI 10; QD 17
3. Demonstrate that reliable scientific evidence improves the ability of scientists to offer accurate predictions.	**Student Edition:** 9 *Figure 3* 8 *Section 1 Review* 13 #2 **Teacher Wraparound Edition:** IL 12; SBC 4E

STANDARDS	PAGE REFERENCES
Ethical Practices	
4. Explain how support of ethical practices in science (e.g., individual observations and confirmations, accurate reporting, peer review and publication) are required to reduce bias.	**Student Edition:** 10 *Science Skills Handbook* 858 **Teacher Wraparound Edition:** CC 10; PR 12
Scientific Theories	
5. Justify that scientific theories are explanations of large bodies of information and/or observations that withstand repeated testing.	**Student Edition:** *Science Online* 12 *Scientific Theories and Laws* 12 **Teacher Wraparound Edition:** SJ 11
6. Explain that inquiry fuels observation and experimentation that produce data that are the foundation of scientific disciplines. Theories are explanations of these data.	**Student Edition:** 7-8 **Teacher Wraparound Edition:** DI 7; RP 6; RS 8; USW 8
7. Recognize that scientific knowledge and explanations have changed over time, almost always building on earlier knowledge.	**Student Edition:** *Integrate History* 218 *Models of the Solar System* 218-219 *National Geographic* 582 *Quarks: Even Smaller Particles* 579-580 *The Limitations of Science* 12 *Time Science & History* 810 **Teacher Wraparound Edition:** A 582; CB 810; CD 8; D 579; HS 810; IHi 219; TFYI 580
Science and Society	
8. Illustrate that much can be learned about the internal workings of science and the nature of science from the study of scientists, their daily work and their efforts to advance scientific knowledge in their area of study.	**Student Edition:** *Time Science & History* 120, 146, 810 *Time Science & Society* 178 **Teacher Wraparound Edition:** CB 120, 178, 810; CD 8; HS 120, 146, 810
9. Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue.	**Student Edition:** *Integrate Careers* 56, 335, 408, 440, 592 **Teacher Wraparound Edition:** IC 56, 335, 408, 440, 592, 753