

EARTH AND SPACE SCIENCE	
Earth's Place in the Universe	MIDDLE SCHOOL
SCRIPTURE	
<i>At the beginning, O Lord, you established the earth, and the heavens are the works of your hands.</i> Heb. 1:10	
STANDARD	
<p>S. 1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. Recognize that just as physical laws exist within our universe, we cannot exist without laws in our spiritual or moral sense. (MS-ESS1-1)</p> <p>S. 2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system and relate the way gravity draws objects together to the way our hearts are drawn toward the Lord, the center of our lives. (MS-ESS1-2)</p> <p>S. 3. Analyze and interpret data to determine scale properties of objects in the solar system. Understand that God transcends the limits of time and space, and seeks a personal relationship with each individual person. (MS-ESS1-3)</p>	
EXAMPLES	
Catholic Scientists/Saints , Catechism , Scripture	
ESSENTIAL QUESTIONS	
<p>S.1, 2 How do gravity and inertia work together to cause cyclical motions within the universe?</p> <p>S.1 What effects do these motions have on what we observe from Earth?</p> <p>S.3 How is the solar system organized?</p>	
ESSENTIAL VOCABULARY	
rotation, axis, revolution, orbit, ellipse, seasons, axial tilt, lunar phase, planetary system, asteroid, meteoroid, comet, astronomical unit, eclipses of the sun and moon, tides, terrestrial vs. gaseous planet formation	
STREAM ACTIVITIES	
<ul style="list-style-type: none"> NASA.gov Lesson Title: Gravity Games, integrates a series of activities designed to demonstrate gravity's role in recreation 	

EARTH AND SPACE SCIENCE	
Earth's Systems	Middle School
SCRIPTURE	
<i>Heaven and earth will pass away, but my words will not pass away.</i> Mt. 25:35 <i>Send forth your spirit, they are created and you renew the face of the earth.</i> Psalms 104:30	
STANDARD	
<p>S.1 Just as reconciliation and purgatory help cleanse and heal our souls, the Earth's natural processes are also necessary for renewal. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. (MS-ESS2-1)</p> <p>S.2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. While discussing weathering and erosion, relate it to the New Testament admonition to "build your house on rock, not on sand"; that we need a firm foundation in Christ to withstand the effects of external forces on our spiritual stability. (MS-ESS2-2)</p> <p>S.3. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. Understand that Genesis's "seven days of creation" is meant to be read as a metaphor, not as a literal scientific explanation. (MS-ESS1-4)</p> <p>S.4. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. This aligns with "divine providence", which states that the universe is "in a state of journeying" and is disposed toward perfection according to God's plan for creation. (MS-ESS2-3)</p> <p>S.5. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. Relate this to the probability that water molecules we interact with today were present in Jesus's baptism at the Jordan River, at the wedding feast at Cana, in the storm on the Sea of Galilee, etc. (MS-ESS2-4)</p> <p>S.6. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. Relate this to the storms described in the New Testament when Jesus calmed the sea, and when he walked on water. (MS-ESS2-5)</p> <p>S.7. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. Apply this to explain the difference between the climate in Galilee and Jerusalem described in the New Testament and our climate in Kansas. (MS-ESS2-6)</p>	
EXAMPLES	
Catholic Scientists/Saints , Catechism , Scripture	
ESSENTIAL QUESTIONS	
<p>S.1, 5, 6, 7 How do materials and energy cycle through the Earth System?</p> <p>S.2, 3, 4 What evidence is there of historical changes in the earth's surface, and how do we see those changes continuing to occur in modern times?</p>	

S.6, 7 What effects on weather and climate do the motion and interactions of air masses, uneven heating, the water cycle, and rotation of the Earth cause?

ESSENTIAL VOCABULARY

Celsius, convection currents, air pressure, wind, warm/cold fronts, air mass, dew point, humidity, wind chill, air occluded front, stationary front, turbulence, updraft, downdraft, plate tectonics, boundaries, divergent, transform fault, mid-ocean ridge, rift, sea floor spreading, continental shelf, trench, igneous, metamorphic, sedimentary, earthquake, focus, epicenter, P waves, S waves, surface waves, Richter scale, Mercalli Scale, precipitation, condensation, transpiration, evaporation

STREAM ACTIVITIES

- Construct Earthquake-Proof Buildings on discoveryeducation.com or Earthquake in the Classroom on techengineering.org
- Mini-terrarium or terraqua column to demonstrate water cycle. Video record (or present live in front of the class) a “weather report” explaining how heat and gravity power the water cycle, and relate it to the weather that will be experienced in various parts of the terrarium.

EARTH AND SPACE SCIENCE

Earth and Human Activity

Middle School

SCRIPTURE

There was a strong and violent wind rending the mountains and crushing rocks before the Lord - but the Lord was not in the wind; after the wind, an earthquake - but the Lord was not in the earthquake; after the earthquake, fire - but the Lord was not in the fire; after the fire, a light silent sound. 1 Kings 19: 11-12

STANDARD

S.1 Construct a scientific explanation based on evidence for how the uneven distribution of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes. Compare the Jordan River of 2000 years ago, where Jesus was baptized by John, to its current state. (MS-ESS3-1)

S.2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. Understand that, while natural disasters can cause distress to humans, they are not direct punishments sent by God, but can become opportunities for us to grow closer to Christ through suffering. (MS-ESS3-2)

S.3. As God’s stewards of the earth, apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. (MS-ESS3-3)

S.4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems. Understand that God’s command to “be fruitful and multiply” also came with the responsibility to care for creation and ensure resources for future generations. (MS-ESS3-4)

S.5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. (MS-ESS3-5)
EXAMPLES
Catholic Scientists/Saints , Catechism , Scripture
ESSENTIAL QUESTIONS
S.1 Why are Earth’s mineral, energy, and groundwater resources unevenly distributed? S.2 How can we use patterns in natural hazards to predict future catastrophic events, and our God-given ingenuity to mitigate their effects? S.3, 4, 5 What impact do humans have on the environment, and how can we reduce the negative effects of human actions and also positively impact Earth’s natural resources and systems?
ESSENTIAL VOCABULARY
renewable and nonrenewable resources, mineral, groundwater, conservation, greenhouse gases, global warming, natural hazards, population density
STREAM ACTIVITIES
<ul style="list-style-type: none"> ● Calculate waste generated by weighing trash generated at lunch time; figure out what percentage of that waste could be recycled or composted by having one school day during which lunch trash is sorted into 3 trash cans (compost, recycling, waste). Present the results graphically to the school community. ● Survey your school grounds for signs of erosion. Discuss potential solutions. Formulate a plan to solve these problems, and possibly correct them as a service project.

Earth’s Place in the Universe

Scriptures:

- *You made the moon to mark the seasons, the sun that knows the hour of its setting. You bring darkness and night falls...* Psalms 104:19-20
- Re. eclipses: *At noon darkness came over the whole land until three in the afternoon.* Mark 15:33 The Death of Jesus

Catechism of the Catholic Church:

- *The beauty of the universe:* **341** The order and harmony of the created world results from the diversity of beings and from the relationships which exist among them. Man discovers them progressively as the laws of nature. They call forth the admiration of scholars. The beauty of creation reflects the infinite beauty of the Creator and ought to inspire the respect and submission of man's intellect and will.
- *God creates an ordered and good world:* **299** Because God creates through wisdom, his creation is ordered: "You have arranged all things by measure and number and

weight."¹⁵¹ The universe, created in and by the eternal Word, the "image of the invisible God", is destined for and addressed to man, himself created in the "image of God" and called to a personal relationship with God.¹⁵² Our human understanding, which shares in the light of the divine intellect, can understand what God tells us by means of his creation, though not without great effort and only in a spirit of humility and respect before the Creator and his work.¹⁵³ Because creation comes forth from God's goodness, it shares in that goodness - "And God saw that it was good. . . very good"¹⁵⁴- for God willed creation as a gift addressed to man, an inheritance destined for and entrusted to him. On many occasions the Church has had to defend the goodness of creation, including that of the physical world

- **CCC 290** In the beginning God created the heavens and the earth":¹²⁸ three things are affirmed in these first words of Scripture: the eternal God gave a beginning to all that exists outside of himself; he alone is Creator (the verb "create" - Hebrew *bara* - always has God for its subject). The totality of what exists (expressed by the formula "the heavens and the earth") depends on the One who gives it being.
- **291** "In the beginning was the Word. . . and the Word was God. . . all things were created through him, and without him was not anything made that was made."¹²⁹ The New Testament reveals that God created everything by the eternal Word, his beloved Son. In him "all things were created, in heaven and on earth.. . all things were created through him and for him. He is before all things, and in him all things hold together."¹³⁰ The Church's faith likewise confesses the creative action of the Holy Spirit, the "giver of life", "the Creator Spirit" (*Veni, Creator Spiritus*), the "source of every good"
- **CCC 294** The glory of God consists in the realization of this manifestation and communication of his goodness, for which the world was created. God made us "to be his sons through Jesus Christ, according to the purpose of his will, *to the praise of his glorious grace*",¹³⁸ for "the glory of God is man fully alive; moreover man's life is the vision of God: if God's revelation through creation has already obtained life for all the beings that dwell on earth, how much more will the Word's manifestation of the Father obtain life for those who see God."¹³⁹ The ultimate purpose of creation is that God "who is the creator of all things may at last become "all in all", thus simultaneously assuring his own glory and our beatitude
- *God transcends creation and is present to it.* **CCC 300** God is infinitely greater than all his works: "You have set your glory above the heavens."¹⁵⁶ Indeed, God's "greatness is unsearchable".¹⁵⁷ But because he is the free and sovereign Creator, the first cause of all that exists, God is present to his creatures' innermost being: " in him we live and move and have our being."¹⁵⁸ In the words of St. Augustine, God is "higher than my highest and more inward than my innermost self".¹⁵⁹

Catholics making contribution to the topic:

- Fr. Robert Spitzer – Current authority on the origin of the universe from a Catholic perspective. Book: *New Proofs for the Existence of God: Contributions of Contemporary Physics and Philosophies*
- Giuseppe Piazzi (1746–1826) – Theatine priest who discovered the asteroid Ceres and did important work cataloguing stars
- Jean Picard (1620–1682) – French priest and father of modern astronomy in France
- Nicolas-Claude Fabri de Peiresc (1580–1637) – Discovered the Orion Nebula
- Nicole Oresme (c.1320–1382) – 14th century bishop who theorized the daily rotation of the earth on its axis
- Christopher Clavius (1538–1612) – Jesuit who was the main architect of the Gregorian calendar
- Nicolaus Copernicus (1473–1543) – First person to formulate a comprehensive heliocentric cosmology
- Fr. Georges Lemaitre- discoverer of the Big Bang Theory
- Nicolas Louis de Lacaille (1713–1762) – French astronomer noted for cataloguing stars, nebulous objects, and constellations

Earth's Systems

Scriptures:

- *Have you entered the storehouses of the snow, and seen the storehouses of the hail Which I have reserved for times of distress, for a day of war and battle? What is the way to the parting of the winds, where the east wind spreads over the earth? Who has laid out a channel for the downpour and a path for the thunderstorm. To bring rain to uninhabited land, the unpeopled wilderness; To drench the desolate wasteland till the desert blooms with verdure? Has the rain a father? Who has begotten the drops of dew? Out of whose womb comes the ice, and who gives the hoarfrost its birth in the skies, when the waters lie covered as though with stone that holds captive the surface of the deep? Have you tied cords to the Pleiades,* or loosened the bonds of Orion? Can you bring forth the Mazzaroth in their season, or guide the Bear with her children? Do you know the ordinances of the heavens; can you put into effect their plan on the earth? Can you raise your voice to the clouds, for them to cover you with a deluge of waters? Can you send forth the lightning on their way, so that they say to you, "Here we are"? Who gives wisdom to the ibis, and gives the rooster understanding? Who counts the clouds with wisdom? Who tilts the water jars of heaven so that the dust of earth is fused into a mass and its clods stick together? Job 38: 22-38*

- *Whose hand holds the depths of the earth, who owns the tops of the mountains. The sea and dry land belong to God, who made them, formed them by hand. Ps 95:4-5*

Catechism of the Catholic Church:

- 282-Catechesis on creation is of major importance. It concerns the very foundations of human and Christian life: for it makes explicit the response of the Christian faith to the basic questions that men of all times have asked themselves: 'Where do we come from..Where does everything that exists come from and where is it going?
- **CCC 293**-Scripture and tradition never ceases to teach and celebrate this fundamental truth: 'The world was made for the glory of God.' St. Bonaventure explains that God created all things 'not to increase His glory, but to show it forth and to communicate it, for God has no other reason for creating than His love and goodness: 'Creatures came into existence when the key of love opened His hand.'
- **CCC 302**-Creation has its own goodness and proper perfection, but it did not spring forth complete from the hands of the Creator. The universe was created 'in a state of journeying' toward an ultimate perfection yet to be attained, to which God has destined it. We call 'divine providence' the dispositions by which God guides His creation towards this perfection:
 - By His providence God protects and governs all things which He has made, 'reaching mightily from one end of the earth to the other, and ordering all things as well.'

Catholics making contribution to the topic:

- Georgius Agricola (1494–1555) – Father of mineralogy
- Nicolas Steno (1638–1686) – Bishop, and father of stratigraphy
- Mario J. Molina (1943–present) - Mexican chemist and one of the precursors to the discovery of the Antarctic ozone hole (1995 Nobel Prize in Chemistry).
- José María Algué (1856–1930) – Priest and meteorologist who invented the barocyclonometer
- Jean Baptiste Julien d'Omalius d'Halloy (1783–1875) – One of the pioneers of modern geology

- Theodoric of Freiberg (c.1250–c.1310) – Gave the first geometrical analysis of the rainbow
- Evangelista Torricelli (1608–1647) – Inventor of the barometer
- Abraham Ortelius (1527–1598) – Created the first modern atlas and theorized on continental drift
- Nicholas Steno (1638-1686) - Convert to Catholicism, Bishop, Father of Geology, anatomist, Dutch born
 - Text support: THE SEASHELL ON THE MOUNTAINTOP: A Story of Science, Sainthood, and the Humble Genius Who Discovered a New History of the Earth, **Alan Cutler, Author**

Earth and Human Activity

Scriptures:

- *The LORD God then took the man and settled him in the garden of Eden, to cultivate and care for it. Genesis 2:15*
- *The one who forms mountains and creates winds, and declares to mortals their thoughts; Who makes dawn into darkness and strides upon the heights of the earth, the LORD, the God of hosts, is his name! Amos 4:13*

Catechism of the Catholic Church:

- **CCC 295** We believe that God created the world according to his wisdom.¹⁴¹ It is not the product of any necessity whatever, nor of blind fate or chance. We believe that it proceeds from God's free will; he wanted to make his creatures share in his being, wisdom and goodness: "For you created all things, and by your will they existed and were created."¹⁴² Therefore the Psalmist exclaims: "O LORD, how manifold are your works! In wisdom you have made them all"; and "The LORD is good to all, and his compassion is over all that he has made.
- **CCC 299** Because God creates through wisdom, his creation is ordered: "You have arranged all things by measure and number and weight."¹⁵¹ The universe, created in and by the eternal Word, the "image of the invisible God", is destined for and addressed to man, himself created in the "image of God" and called to a personal relationship with God.¹⁵² Our human understanding, which shares in the light of the divine intellect, can understand what God tells us by means of his creation, though not without great effort and only in a spirit of humility and respect before the Creator and his work.¹⁵³ Because creation comes forth from God's goodness, it shares in that goodness - "And God saw that it was good. . . very good"¹⁵⁴- for God willed creation as a gift addressed to man, an

inheritance destined for and entrusted to him. On many occasions the Church has had to defend the goodness of creation, including that of the physical world.

- **CCC 2415** The seventh commandment enjoins respect for the integrity of creation. Animals, like plants and inanimate beings, are by nature destined for the common good of past, present, and future humanity.¹⁹⁵ Use of the mineral, vegetable, and animal resources of the universe cannot be divorced from respect for moral imperatives. Man's dominion over inanimate and other living beings granted by the Creator is not absolute; it is limited by concern for the quality of life of his neighbor, including generations to come; it requires a religious respect for the integrity of creation.¹⁹⁶

Catholics making contribution to the topic:

- Dr. James Schaefer, Marquette University, reminds us of our Christian heritage
- Sr. Marjorie Keenan, RSHM author of the book *Ethics and the Environment: Towards Oneness in Life*
- Thomas Berry (1914-2009)- eco-theologian author of *A Great Work*
- Saint Kateri Tekakwitha (1656 – 1680) Known for being a good steward of the Earth, patron saint of the environment and ecology
- Wangari Maathai (1940-2011) - founder of the Green Belt Movement, 2004 Nobel Prize Peace Prize winner for her work in Kenya as an environmental and social/political activist