PHYSICAL SCIENCE
Matter and Its Interactions **MIDDLE SCHOOL**
SCRIPTURE
In the beginning, when God-created the heavens and the earth, and the earth was a formless wasteland, and darkness covered the abyss. Gen 1: 1-2
STANDARD
S. 1. Understanding that God created all matter in the beginning, develop a model to describe the atomic composition of simple molecules and extended structures. (MSPS1-1) S. 2. Reflecting on how God is at work in our hearts to bring about a change, analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. (MS-PS1-2) S. 3 Knowing God has called us to care for the Earth, and knowing our responsibility due to our unique place in creation, gather and make sense of information to describe that synthetic materials come from natural resources and impact society. (MS-PS1-3) S. 4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed, just as God's energy is at work producing a change in us when we are open to cooperating with his divine plan. (MS-PS1-4) S. 5. Understanding that all things were created by God *ex nihilo*, develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. (MS-PS1-5) S. 6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. Discuss how this relates to the way that the apostles absorbed the spiritual energy of the Holy Spirit when it descended upon them as tongues of fire in the Upper Room. (MS-PS1-6)
EXAMPLES
Catholic Scientists/Saints, Catechism, Scripture
ESSENTIAL QUESTIONS
1. How do simple molecules bond to create more complex structures? 2. What observations can be made to determine if a chemical reaction has occurred? 3. How do synthetic materials, which come from natural resources, impact our society? 4. How does an increase or decrease in thermal energy impact particle motion? 5. How do the reactants and products compare before and after a chemical reaction? 6. What types of devices release or absorb thermal energy using a chemical process?
ESSENTIAL VOCABULARY
atoms, matter, elements, molecule, compounds, mixtures, protons, neutrons, electrons, nucleus, states of matter, solid, liquid, gas, plasma, boiling point, melting point, freezing point, sublimation, condensation, evaporation, periodic table, group, periods ,atomic number, atomic mass, atomic structure, nonmetal, metals, covalent bond, ionic bond, electron shell, valence electrons, law of conservation of matter, symbols, yields, subscript, co-efficient,

balanced equation, catalyst, inhibitor, endothermic, exothermic, synthesis, decomposition, single replacement, double replacement, combustion, acid-base reaction, solubility, Ph paper, acid, base, hydroxide ion, hydronium ion, blue litmus, red litmus, indicator strip
STREAM ACTIVITIES
● Mystery pH lab: given various liquids and pH indicator strips determine pH, possible purpose of the solution and try to correctly identify the solution ● Mystery density lab: given different liquid solutions determine which has a greater density ● Adopt an element - https://sciencespot.net/Media/adtelempjt.pdf ● Playing with polymers - https://sciencespot.net/Media/playpolyrecipe08.pdf

PHYSICAL SCIENCE	
Motion and Stability: Forces and Interactions	MIDDLE SCHOOL

SCRIPTURE

And he is before all things, and in him all things hold together. Colossians 1:17

STANDARD

S.1. Understanding that God set all things in motion, apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. (MS-PS2-1)

S.2. Understanding that all of creation is in perfect balance, plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. (MS-PS2-2)

S.3. Understanding that all aspects of God's creation were planned and act as they were created to act, apply scientific inquiry to determine the factors that affect the strength of electric and magnetic forces. (MS-PS2-3)

S.4. Just as all things are held together through Christ who strengthens us, construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. (MS-PS2-4)

S.5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. These forces are similar to the way our souls are invisibly drawn to union with God. (MS-PS2-5)

EXAMPLES

Catholic Scientists/Saints, Catechism, Scripture

ESSENTIAL QUESTIONS

1. and 2 How can Newton's Laws explain and predict a change in motion or stability of an object or the interaction of objects?
3. What factors affect the strength of electric and magnetic forces?
4. How does the mass of an object affect its gravitational force?
5. Why are some physical systems more stable than others?

ESSENTIAL VOCABULARY

metric measurement, mass, grams, liters, meters, density, volume, temperature, Celsius, Newton's First, Second, and Third Law of motion, inertia, friction, motion, reference point, speed, velocity, momentum, acceleration, deceleration, gravity, weight, force, balanced and unbalanced forces, newtons, work, Joules, power, watts, Potential Energy, Kinetic Energy

STREAM ACTIVITIES

- Magnetic Forces: Build a simple nail electromagnet and study how electric currents create magnetic fields.
- Newton's Laws: Assessment- Given a ball, the student will demonstrate all three of Newton's Laws of motion,
- Marble madness competition to construct a marble track to decrease the speed of a marble given certain parameters

- Rubber Band Lab- https://www.scientificamerican.com/article/bring-science-home-rubber-bands-energy/

PHYSICAL SCIENCE	
Energy	MIDDLE SCHOOL
SCRIPTURE	
Then God said, 'Let there be light,' and there was light. Gen 1:3	
STANDARD	
S.1. Understanding the perfect balance of all forces of objects created by God in the beginning, construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and the speed of an object. (MS-PS3-1) S.2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. Our potential, God says, is like the mustard seed. To human appearance, it is tiny, but God tells us that through His grace, our faith can grow "to the largest of plants" that gives shelter to others. (MS-PS3-2) S.3. Investigating St. Albertus Magnus and the scientific method, apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. (MS-PS3-3) S.4. Plan an investigation to determine the relationships among God's creation of a good and ordered world to show energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. (MS-PS3-4) S.5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object, just as we were created to allow the transforming energy of the Holy Spirit to act on and sanctify our life. (MS-PS3-5)	
EXAMPLES	
Catholic Scientists/Saints, Catechism, Scripture	
ESSENTIAL QUESTIONS	
1. How does an object's mass and speed impact its kinetic energy? 2. What is the relationship between objects' interactions and their respective potential energies? 3. What type of device can minimize or maximize thermal energy transfer? 4. How does a change in temperature indicate a thermal energy transfer? 5. How is energy transferred between objects or systems?	
ESSENTIAL VOCABULARY	
Conduction, convection, radiation, Conservation of energy, potential and kinetic energy, mass, speed, acceleration, thermal energy, energy transfer, types of energy, heat, temperature, Celsius, fusion, fission	
STREAM ACTIVITIES	

- Thermal Energy Transfer: build/ design solar ovens or ice cube insulators
- Transfer of energy: build/design a roller coaster demonstrating kinetic and potential energy, marble madness competition to construct a marble track to decrease the speed of a marble given certain parameters,
- charge a plastic grocery bag to create potential energy that transfers to kinetic when a hand is placed near.

PHYSICAL SCIENCE
Waves and Their Applications in Technologies for Information Transfer **MIDDLE SCHOOL**
SCRIPTURE
The men were amazed and asked, "What kind of man is this? Even the winds and the waves obey him! Matthew 8:23
STANDARD
S.1. Just as the Holy Spirit is a force at work in our hearts, and our openness to God's will allow for greater movement in us, use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. (MS-PS4-1) S.2.Develop and use a model to describe that waves are absorbed, reflected, or transmitted through various materials, just as through our openness to God's will, we are able to absorb his Word, reflect his goodness in our actions, and transmit his love to others. (MS-PS4-2) S.3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals, understanding that God gave to man an intellect and ability to reason with logic. (MS-PS4-3)
EXAMPLES
Catholic Scientists/Saints, Catechism, Scripture
ESSENTIAL QUESTIONS
1. What are the characteristics and properties of waves? 2. How do waves behave when reflected, absorbed or transmitted through different materials? 3. How are digitized signals different from analog signals?
ESSENTIAL VOCABULARY
wave, amplitude, crests, troughs, types of waves, reflected, absorbed, transmitted, refracted, compression, analog signals, encode, transmit, Doppler, electricity, magnetism, vibration, spectrum, conductor, insulator, pole
STREAM ACTIVITIES
● Using a slinky, rope and dominos demonstrate different wave patterns ● Use the example of popcorn transforming from a kernel when introduced to a radio wave ● Investigate how water can refract light waves and change the perception of an object's location ● Use prisms to explore what makes up light waves ● Demonstrate the Doppler effect by listening to a sound in motion

Matter and Its Interactions

Scriptures:

- *In the beginning was the Word, and the Word was with God, and the Word was God. He was in the beginning with God. All things came to be through him, and without him nothing came to be. What came to be through him was life, and this life was the light of the human race; the light shines in the darkness, and the darkness has not overcome it.* John 1:1-5
- *By faith we understand that the universe was ordered by the word of God, so that what is visible came into being through the invisible.* Heb 11:3
- *When the time for Pentecost was fulfilled, they were all in one place together. And suddenly there came from the sky a noise like a strong driving wind, and it filled the entire house in which they were. Then there appeared to them tongues as of fire, which parted and came to rest on each one of them. And they were all filled with the holy Spirit and began to speak in different tongues, as the Spirit enabled them to proclaim.* Acts 2:1-4 **(Relate the radical change in the apostles' characteristics - fearful and hiding in the Upper Room, to going out and boldly proclaiming the gospel - after the Holy Spirit has entered them, to the way that chemical changes cause a change in the substance and characteristics of matter.)**

Catechism of the Catholic Church:

- **CCC 298** Since God could create everything out of nothing, he can also, through the Holy Spirit, give spiritual life to sinners by creating a pure heart in them,[148] and bodily life to the dead through the Resurrection. God "gives life to the dead and calls into existence the things that do not exist."[149] And since God was able to make light shine in darkness by his Word, he can also give the light of faith to those who do not yet know him.
- **CCC 293** Scripture and Tradition never ceases to teach and celebrate this fundamental truth: "The world was made for the glory of God."[134] St. Bonaventure explains that God created all things "not to increase his glory, but to show it forth and to communicate it",[135] 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."[136] The First Vatican Council explains:

  This one, true God, of his own goodness and "almighty power", not for increasing his own beatitude, nor for attaining his perfection, but in order to manifest this perfection through the benefits which he bestows on creatures, with absolute freedom of counsel "and from the beginning of time, made out of nothing both orders of creatures, the spiritual and the corporeal. . ."[137]

Catholics making contribution to the topic:

- Fr. Robert Spitzer (1952- present) – 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*
- Jean-Baptiste Dumas (1800–1884) – Chemist who established new values for the atomic mass of thirty elements
- Henri Becquerel (1852–1908) – Awarded the Nobel Prize in physics for his co-discovery of radioactivity
- Fibonacci (c.1170–c.1250) – Popularized Hindu-Arabic numerals in Europe and discovered the Fibonacci sequence
- Fr. Georges Lemaitre (1894-1966) - discoverer of the Big Bang Theory
- Pope Francis (1936-present) Chemical engineer

Motion and Stability: Forces and Interactions

Scriptures:

- *No one can come to me unless the Father who sent me draw him* John 6:44
- *Jesus, aware at once that power had gone out from him, turned around in the crowd and asked, "Who has touched my clothes?"* Mark 5:30

Catechism of the Catholic Church:

- **296** We believe that God needs no pre-existent thing or any help in order to create, nor is creation any sort of necessary emanation from the divine substance.[144] God creates freely "out of nothing".
- **821** Certain things are required in order to respond adequately to this call:
  - a permanent *renewal* of the Church in greater fidelity to her vocation; such renewal is the **driving-force** of the **movement toward unity**; (bolded emphasis added to relate to science standards)

Catholics making contribution to the topic:

- André-Marie Ampère (1775–1836) – One of the main discoverers of electromagnetism
- Galileo Galilei (1564–1642) – Father of modern science
- Giovanni Battista Riccioli(1598 –1671) was an Italian astronomer and a Catholic priest in the Jesuit order. He is known, among other things, for his experiments with pendulums and with falling bodies, for his discussion of 126 arguments concerning the motion of the Earth, and for introducing the current scheme of lunar nomenclature.

- Bonaventura Cavalieri (1598–1647) – Mathematician known for his work in optics and motion, calculus, and for introducing logarithms to Italy
- Jean Buridan (c.1300–after 1358) – French priest who developed the theory of impetus, the first step toward the modern concept of inertia
- Francesco Lana de Terzi (1631–1687) – Jesuit priest who has been called the father of aeronautics
- Pierre-Simon Laplace (1749–1827) – Famed mathematician and astronomer who has been called the "Newton of France"

Energy

Scriptures:

- Therefore, if anyone is in Christ, he is a new creation. The old has passed away; behold, the new has come. All this is from God, who through Christ. 2 Corinthians 5:17

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."[143]
- 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.[155]

Catholics making contribution to the topic:

- Eugenio Barsanti (1821–1864) – Piarist who is the possible inventor of the internal combustion engine
- Andrew Gordon (Benedictine) (1712–1751) – Benedictine monk, physicist, and inventor who made the first electric motor
- John Polanyi (1929–) – Canadian chemist who won the 1986 Nobel Prize for his research in chemical kinetics

Waves and Their Applications in Technologies for Information Transfer:

Scriptures:

- So God created the great creatures of the sea and every living thing with which the water teems and that moves about in it, according to their kinds, and every winged bird according to its kind. And God saw that it was good. Genesis 1:21
- Then God said, “Let us make mankind in our image, in our likeness, so that they may rule over the fish in the sea and the birds in the sky, over the livestock and all the wild animals, and over all the creatures that move along the ground.” Genesis 1:23
- “You rule over the surging sea; when its waves mount up, you still them.” Psalm 89:9

Catechism of the Catholic Church:

- CCC 2493 Within modern society the communications media play a major role in information, cultural promotion, and formation. This role is increasing, as a result of technological progress, the extent and diversity of the news transmitted, and the influence exercised on public opinion.

Catholics making contribution to the topic:

- Francesco Maria Grimaldi (1618–1663) – Jesuit who discovered the diffraction of light
- Étienne-Louis Malus (1775–1812) – Discovered the polarization of light
- Guglielmo Marconi (1874–1937) – Father of long-distance radio transmission
- Christopher Clavius (1538–1612) – Jesuit who was the main architect of the Gregorian calendar
- René Descartes (1596–1650) – Father of modern philosophy and analytic geometry
- Giuseppe Mercalli (1850–1914) – Priest, volcanologist, and director of the Vesuvius Observatory who is best remembered today for his Mercalli scale for measuring earthquakes which is still in use
- Marin Mersenne (1588–1648) – Minim philosopher, mathematician, and music theorist who is often referred to as the "father of acoustics"

- Jozef Murgaš (1864–1929) – Priest who contributed to wireless telegraphy and help develop mobile communications and wireless transmission of information and human voice
- Saint Lucy (283–304) - Saint of light