



**DUBLIN**  
CITY SCHOOLS

**K-12 SCIENCE**  
**Graded Course of Study**  
**2025**



## Dublin City Schools K-12 Science Graded Course of Study

A K-12 Dublin City Schools science education aims to create lifelong learners who are curious, critical thinkers, and effective collaborators, equipped with the scientific knowledge and skills necessary to navigate and shape a complex and ever-changing world.

Our vision is to inspire students to develop a deep appreciation for science and its applications, empowering them to:

- Ask questions, seek answers, and explore the natural world with a sense of wonder and curiosity.
- Think critically and creatively to solve problems and make informed decisions as a scientifically literate citizen.
- Communicate and collaborate effectively in our diverse community and beyond to address common challenges and create innovative solutions.
- Build their own identity as a scientist in order to apply scientific concepts and methods to understand and address real-world issues competently and confidently.
- Develop the resilience, adaptability, and perseverance needed to succeed in a rapidly evolving world.

### Instructional Agreements for Science Learning within the Dublin City Schools

- Teachers will provide opportunities for students to engage in hands-on experiences, projects, and real-world simulations to provide context and relevance to science concepts.
- Teachers will create an environment that emphasizes the importance of effort, perseverance, and reflection in order to learn and grow from both success and failure.
- Content standards will be learned in conjunction with best practices regarding science education.

Together, we will cultivate resourceful, adaptable, and collaborative individuals with the ability to tackle real-world challenges with resilience and innovation.



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**Nature of Science**

One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.

**Scientific Inquiry, Practice and Applications**

All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.

**Science is a Way of Knowing**

Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.

**Science is a Human Endeavor**

Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, abilities, family backgrounds and incomes.

**Scientific Knowledge is Open to Revision in Light of New Evidence**

Science is not static. Science is constantly changing as we acquire more knowledge.

**Scientific and Engineering Practices:**

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information



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**Ohio's Cognitive Demands for Science**

Educators will refer to "Ohio's Cognitive Demands for Science" to create experiences for students to engage in science content and demonstrate understanding of scientific concepts in ways that align with current research about how people learn.

**DESIGNING TECHNOLOGICAL/  
ENGINEERING SOLUTIONS  
USING SCIENCE CONCEPTS**

Requires students to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information.

**DEMONSTRATING SCIENCE  
KNOWLEDGE**

Requires students to use scientific practices and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. (Slightly altered from National Science Education Standards)

**INTERPRETING AND  
COMMUNICATING SCIENCE  
CONCEPTS**

Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

**RECALLING ACCURATE  
SCIENCE**

Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.



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## Physical Science

### Course Goals

Physical science introduces students to key concepts and theories that provide a foundation for further study in other sciences and advanced science disciplines. Physical science comprises the systematic study of the physical world as it relates to fundamental concepts about matter, energy and motion. A unified understanding of phenomena in physical, living, Earth and space systems is the culmination of all previously learned concepts related to chemistry, physics, and Earth and space science, along with historical perspective and mathematical reasoning.

STUDY OF MATTER	
Matter was introduced in the elementary grades and the learning progression continued through middle school to include differences in the physical properties of solids, liquids and gases. Elements, compounds, mixtures, molecules, kinetic and potential energy and the particulate nature of matter were introduced. Content in Chemistry (e.g., electron configuration, molecular shapes, bond angles) will build on concepts in this course.	
Content Statement	Content Elaboration
<b>PS.M.1: Classification of matter</b>	<p>Heterogeneous vs. homogeneous</p> <ul style="list-style-type: none"><li>• Solutes and Solvents</li><li>• Acids &amp; bases (identify according to pH)</li></ul> <p>Properties of matter</p> <ul style="list-style-type: none"><li>• Physical Properties: color, solubility, odor, hardness, conductivity, melting/boiling point, viscosity, malleability</li><li>• Chemical Properties: reactivity, flammability, pH</li></ul> <p>States of matter and its changes</p> <ul style="list-style-type: none"><li>• Phase changes</li><li>• Endothermic and Exothermic</li></ul>
<b>PS.M.2: Atoms</b>	<p>Atoms</p> <ul style="list-style-type: none"><li>• Components of atoms (protons, neutrons, electrons)</li></ul>



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	<ul style="list-style-type: none"><li>• Ions (cations and anions)</li><li>• Isotopes</li></ul>
<b>PS.M.3: Periodic trends of the elements</b>	The Periodic Table <ul style="list-style-type: none"><li>• Arranged by group or family</li><li>• Periodic law</li></ul>
<b>PS.M.4: Bonding and compounds</b>	Chemical components <ul style="list-style-type: none"><li>• Bonding (ionic and covalent)</li><li>• 3D Lattice</li></ul> Nomenclature <ul style="list-style-type: none"><li>• Ionic: Formulas of ionic compounds from groups 1, 2, 17, H &amp; O</li><li>• Covalent: use prefixes 1-10</li></ul>
<b>PS.M.5: Reactions of matter</b>	Chemical reactions <ul style="list-style-type: none"><li>• Transfer of thermal energy (endothermic &amp; exothermic)</li><li>• Chemical equations are balanced to reflect the Law of Conservation of matter</li></ul> Nuclear reactions <ul style="list-style-type: none"><li>• Changes to nucleus, larger energy than chemical reactions</li><li>• Strong nuclear force greater than repulsive electrical forces (imbalance leads to unstable nucleus)</li><li>• Radioisotopes undergo alpha or beta decay, resulting nuclear reaction can be written</li><li>• Half life graphs (amount of radioisotope vs. time)</li><li>• Whole number integers of half-life only</li><li>• Fission, fusion reactions</li><li>• Using nuclear reactions for energy</li></ul>

## THE UNIVERSE

In early elementary school, observations of the sky and space are the foundation for developing a deeper knowledge of the solar system. In late elementary school, the parts of the solar system are introduced, including characteristics of the sun and planets, orbits and celestial bodies. At the middle school level, energy, waves, gravity and density are emphasized in the physical sciences, and characteristics and patterns within the solar system are explored. In this course, the universe and galaxies are introduced, building upon the knowledge about space and the solar system from earlier grades



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<b>PS.U.1: History of the universe</b>	<p>Big bang theory is accepted explanation for origin &amp; evolution of the universe</p> <ul style="list-style-type: none"> <li>Supporting evidence for the expansion of the known universe: Hubble’s law, red shift, cosmic background radiation</li> </ul> <p>Roles of telescopes, space probes, accelerators &amp; technology in simulating and computing data</p>
<b>PS.U.2: Galaxies</b>	<p>Classification of galaxies by size and shape: elliptical, spiral, irregular</p> <p>Milky Way galaxy classification and characteristics</p> <ul style="list-style-type: none"> <li>Spiral galaxy</li> <li>Center is a massive black hole</li> </ul> <p>Hubble’s law and its relationship to Red Shift/Doppler Shift</p>
<b>PS.U.3: Stars</b>	<p>Live cycles of stars</p> <ul style="list-style-type: none"> <li>Formation of stars, importance of Hydrogen, Helium, fusion, and gravitational attraction</li> <li>Focus is on the interpretation of data and NOT memorization of the names of stars and names of evolutionary stages</li> </ul> <p>Fusion in stars</p> <ul style="list-style-type: none"> <li>Basis of all elements beyond hydrogen, helium, and lithium</li> </ul>

**ENERGY AND WAVES**

Building upon knowledge gained in elementary and middle school, major concepts about energy are further developed. Conceptual knowledge will move from qualitative understandings of energy to ones that are more quantitative using mathematical formulas, manipulations and graphical representations.

Content Statement	Content Elaboration
<b>PS.EW.1: Conservation of energy</b>	<p>Quantifying kinetic energy</p> <ul style="list-style-type: none"> <li><math>E_k = \frac{1}{2} mv^2</math></li> </ul>



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	<p>Quantifying gravitational potential energy</p> <ul style="list-style-type: none"><li>• <math>E_g = mgh</math></li></ul> <p>Calculating conservation of energy within open and closed systems</p> <ul style="list-style-type: none"><li>• Collecting data in experimental situations (examples: swinging pendulum, roller coaster with multiple heights and velocities, Skateboard vert ramp)</li></ul>
<b>PS.EW.2: Transfer and transformation of energy</b>	<p>Representations of Work</p> <ul style="list-style-type: none"><li>• <math>W = F\Delta x</math> or <math>\Delta E</math></li></ul> <p>Energy transformations</p> <ul style="list-style-type: none"><li>• Conceptual understanding of kinetic energy, potential energy and work combined with the law of conservation of energy</li><li>• Using pie graphs or bar graphs to represent energy transformations within both open and closed systems</li></ul>
<b>PS.EW.3: Waves</b>	<p>Refraction, reflection, diffraction, absorption, superposition (constructive and destructive interference)</p> <ul style="list-style-type: none"><li>• Understanding the conceptual nature of each type of wave interaction</li></ul> <p>Radiant energy and the electromagnetic spectrum</p> <ul style="list-style-type: none"><li>• Radiant energy does not require a medium, wide range of frequencies</li><li>• Light energy radiates in all directions</li><li>• Electromagnetic spectrum (relative position of radio to gamma)</li><li>• Differences in wave behavior based on material (opaque, transparent materials)</li></ul> <p>Doppler shift</p> <ul style="list-style-type: none"><li>• Change in wavelength &amp; frequency based on location of observer &amp; wave source</li><li>• Connect to expansion of the universe (red-shift)</li><li>• Calculations to measure the apparent change in frequency or wavelength are not appropriate for this course</li></ul>
<b>PS.EW.4: Thermal energy*</b>	<p>Rates of thermal energy transfer/thermal equilibrium</p> <ul style="list-style-type: none"><li>• Graph changes in temperature to compare insulators ability to insulate</li></ul> <p>Conductors have higher rate of transfer than insulators</p>



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	<ul style="list-style-type: none"> <li>Conductive capacity as a comparative measure between different objects/matter</li> </ul> <p>Rate of thermal energy absorption impacted by: temperature, color, texture, exposed surface area and elaborate on phase of matter change as a result</p>
<b>PS.EW.5: Electricity*</b>	<p>Movement of electrons</p> <ul style="list-style-type: none"> <li>Define and measure current, voltage, and resistance</li> <li>Conceptual understanding between current, voltage, and resistance in a circuit</li> <li>Identify conductors and insulators based on electron movement</li> </ul>

\*This standard is not addressed in Grade 8/Telescoped Physical Science

**FORCES AND MOTION**

Building upon content in elementary and middle school, major concepts of motion and forces are further developed. In this course, mathematics (including graphing) is used when describing these phenomena, moving from qualitative understanding to one that is more quantitative. Motion is limited to segments of uniform motion (e.g., at rest, constant velocity, constant acceleration) in a straight line either horizontally, vertically, up an incline or down an incline. Motions of two objects may be compared or addressed simultaneously (e.g., when or where would they meet).

Content Statement	Content Elaboration
<b>PS.FM.1: Motion</b>	<p>Introduction to one-dimensional vectors</p> <ul style="list-style-type: none"> <li>Frame of reference described in terms of: distance, position, displacement, speed, velocity, acceleration, time</li> <li>Drawing motion diagrams for position &amp; velocity</li> </ul> <p>Displacement, velocity (constant, average and instantaneous) and acceleration</p> <ul style="list-style-type: none"> <li>Displacement: <math>\Delta x = x_f - x_i</math></li> <li>Provide examples where distance does not equal displacement</li> <li><math>v_{avg} = (x_f - x_i) / (t_f - t_i)</math></li> <li>Provide examples where avg speed is not the same as avg velocity</li> <li>Position, displacement, velocity, acceleration all vector (magnitude and direction)</li> <li><math>a_{avg} = (v_f - v_i) / (t_f - t_i)</math></li> <li>Acceleration can be negative, but specific examples of +/- acceleration addressed in physics</li> </ul>



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	<ul style="list-style-type: none"><li>• Constant acceleration</li></ul> <p>Interpreting position vs. time and velocity vs. time graphs</p> <ul style="list-style-type: none"><li>• Graphs include objects at rest, moving at a constant velocity and moving at a constant acceleration, both positive and negative</li><li>• Calculate slope &amp; use to interpret motion</li><li>• Collect data (motion detectors for graphing and analysis)</li></ul>
<b>PS.FM.2: Forces</b>	<p>Forces, measuring and representing</p> <ul style="list-style-type: none"><li>• <math>1\text{N} = 1\text{kg}\cdot 1\text{m}/\text{s}^2</math></li><li>• Opportunities to measure force</li><li>• Force diagrams are constructed and interpreted</li></ul> <p>Types of forces (gravity, friction, normal, tension, applied)</p> <ul style="list-style-type: none"><li>• Conceptual introduction of normal/tension forces</li><li>• Gravitational force (weight) calculated from mass, all other forces from force diagrams</li><li>• <math>F_g = mg</math> (<math>g = 9.8\text{ N/kg}</math> or <math>\text{m}/\text{s}^2</math>)</li><li>• Forces in one dimension are analyzed</li><li>• Conceptual introduction of sliding vs. kinetic friction</li><li>• Net force is determined through vector addition</li></ul> <p>Field model for forces at a distance (Magnetic, Electric and Gravitational)</p> <ul style="list-style-type: none"><li>• The stronger the field, the greater the force exerted on objects</li></ul>
<b>PS.FM.3: Dynamics</b>	<p>Understand and apply Newton's Three Laws of Motion</p> <p>Unbalanced forces cause changes in motion (acceleration) whereas balanced forces do not.</p> <ul style="list-style-type: none"><li>• When <math>F_{\text{net}} = 0</math>, object does not accelerate</li><li>• <math>F_{\text{net}} = ma</math></li><li>• Accelerating objects</li></ul>