Physics 30S Curriculum Outcomes

115 Total Outcomes

TOPIC 1.1: Waves in One Dimension

Students will be able to:

S3P-1-01 Describe a wave as a transfer of energy.
Include: medium, mechanical wave, pulse, periodic wave

S3P-1-02 Describe, demonstrate, and diagram the characteristics of transverse and longitudinal waves.
Include: crest, trough, amplitude, wavelength, compression, rarefaction

S3P-1-03 Compare and contrast the frequency and period of a periodic wave.
Include: $T = \frac{1}{f}$

S3P-1-04 Derive and solve problems, using the wave equation ($v = \lambda f$)

S3P-1-05 Describe, demonstrate, and diagram the transmission and reflection of waves travelling in one dimension.
Include: free and fixed ends, different media

S3P-1-06 Use the principle of superposition to illustrate graphically the result of combining two waves.
Include: constructive and destructive interference, nodes, antinodes, standing waves

S3P-1-07 Investigate the historical development of a significant application of communications technology that uses waves.
Examples: telephone, radio, television, cell phone, communications satellite, motion detectors, remote controls…

TOPIC 1.2: Waves in Two Dimensions

Students will be able to:

S3P-1-08 Describe and give examples of two-dimensional waves.

S3P-1-09 Compare and contrast a wavefront and a wave ray.

S3P-1-10 Describe, demonstrate, and diagram the reflection of plane (straight) and circular waves.
Include: linear and parabolic reflectors

S3P-1-11 Describe, demonstrate, and diagram the refraction of plane (straight) waves.

S3P-1-12 Derive Snell's Law using the relationships between wavelength, velocity, and the angles of incidence and refraction.

S3P-1-13 Experiment to demonstrate Snell's Law.

S3P-1-14 Describe, demonstrate, and diagram diffraction of water waves.

S3P-1-15 Describe, demonstrate, and diagram how constructive and destructive interference produce an interference pattern from two point sources.

S3P-1-16 Derive the path difference relationship for the interference pattern from two point sources

$$|\overline{P_nS_1} - \overline{P_nS_2}| = \left(n - \frac{1}{2}\right)\lambda$$

TOPIC 1.3: Sound

Students will be able to:

S3P-1-17 Investigate to analyze and explain how sounds are produced, transmitted, and detected, using examples from nature and technology.
Examples: production of sound by a vibrating object, drums, guitar strings, cricket, hummingbird, dolphin, piezocrystal, speakers…

S3P-1-18 Use the decision-making process to analyze an issue related to noise in the environment.
Examples: sonic boom, traffic noise, concert halls, loudspeakers, leaf blowers…

S3P-1-19 Design, construct (or assemble), test, and demonstrate a technological device to produce, transmit, and/or control sound waves for a useful purpose.
Examples: sound barrier or protective headphones to reduce the effects of noise, electromagnetic speakers, echo chamber, microphone, musical instruments, guitar pickup, electronic tuner, sonar detector, anechoic chamber, communication devices…

S3P-1-20 Describe and explain in qualitative terms what happens when sound waves interact (interfere) with one another.
Include: production of beats

S3P-1-21 Experiment to analyze the principle of resonance and identify the conditions required for resonance to occur.
Include: open- and closed-column resonant lengths

S3P-1-22 Experiment to calculate the speed of sound in air.

S3P-1-23 Compare the speed of sound in different media, and explain how the type of media and temperature affect the speed of sound.

S3P-1-24 Explain the Doppler effect, and predict in qualitative terms the frequency change that will occur for a stationary and a moving observer.

S3P-1-25 Define the decibel scale qualitatively, and give examples of sounds at various levels.

S3P-1-26 Describe the diverse applications of sound waves in medical devices, and evaluate the contribution to our health and safety of sound-wave based technologies.
Examples: hearing aid, ultrasound, stethoscope, cochlear implants…

S3P-1-27 Explain in qualitative terms how frequency, amplitude, and wave shape affect the pitch, intensity, and quality of tones produced by musical instruments.
Include: wind, percussion, stringed instruments

S3P-1-28 Examine the octave in a diatonic scale in terms of frequency relationships and major triads.

28 OUTCOMES

TOPIC 2.1: MODELS, LAWS, AND THEORIES

Students will be able to:

S3P-2-01 Use a mystery container activity to outline the relationships among observations, inferences, models, and laws.

S3P-2-02 Plan and perform an experiment to identify a linear pattern between two variables and state the pattern as a mathematical relationship (law).
Include: visual, numeric, graphical, and symbolic modes of representation

S3P-2-03 Describe the relationships among knowledge claims, evidence, and evidential arguments.
Include: atomic model of matter, a relevant advertising claim

S3P-2-04 Outline the tentative nature of scientific theories.
Include: speculative and robust theories

S3P-2-05 Describe the characteristics of a good theory.
Include: accuracy, simplicity, and explanatory power

TOPIC 2.2: PARTICLE AND WAVE MODELS OF LIGHT

Students will be able to:

S3P-2-06 Outline several historical models used to explain the nature of light.
Include: tactile, emission, particle, wave models

S3P-2-07 Summarize the early evidence for Newton's particle model of light.
Include: propagation, reflection, refraction, dispersion

S3P-2-08 Experiment to show the particle model of light predicts that the velocity of light in a refractive medium is greater than the velocity of light in an incident medium $(v_r > v_i)$.

S3P-2-09 Outline the historical contribution of Galileo, Roemer, Huygens, Fizeau, Foucault, and Michelson to the development of the measurement of the speed of light.

S3P-2-10 Describe phenomena that are discrepant to the particle model of light.
Include: diffraction, partial reflection and refraction of light

S3P-2-11 Summarize the evidence for the wave model of light.
Include: propagation, reflection, refraction, partial reflection/refraction, diffraction, dispersion

S3P-2-12 Compare the velocity of light in a refractive medium predicted by the wave model with that predicted in the particle model.

S3P-2-13 Outline the geometry of a two-point-source interference pattern, using the wave model.

S3P-2-14 Perform Young's experiment for double-slit diffraction of light to calculate the wavelength of light.
Include: $\lambda = \frac{\Delta x d}{L}$

S3P-2-15 Describe light as an electromagnetic wave.

S3P-2-16 Discuss Einstein's explanation of the photoelectric effect qualitatively.

S3P-2-17 Evaluate the particle and wave models of light and outline the currently accepted view.
Include: the principle of complementarity

TOPIC 3.1: KINEMATICS

The student will be able to:

S3P-3-01: Differentiate between, and give examples of, scalar and vector quantities.
Examples: distance, speed, mass, time, temperature, volume, weight, position, displacement, velocity, acceleration, force…

S3P-3-02: Differentiate among position, displacement, and distance.

S3P-3-03: Differentiate between the terms “an instant” and “an interval” of time.

S3P-3-04: Analyze the relationships among position, velocity, acceleration, and time for an object that is accelerating at a constant rate.
Include: transformations of position-time, velocity-time, and acceleration-time graphs using slopes and areas

S3P-3-05: Compare and contrast average and instantaneous velocity for non-uniform motion.
Include: slopes of chords and tangents

S3P-3-06: Illustrate, using velocity-time graphs of uniformly accelerated motion, that average velocity can be represented as $\vec{v}_{avg} = \frac{\Delta\vec{d}}{\Delta t}$ and that displacement can be calculated as $\Delta\vec{d} = \frac{\vec{v}_1+\vec{v}_2}{2}\Delta t$

S3P-3-07: Solve problems, using combined forms of: $\vec{v}_{avg} = \frac{\vec{v}_1+\vec{v}_2}{2}$ $\vec{v}_{avg} = \frac{\Delta\vec{d}}{\Delta t}$ $\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t}$

TOPIC 3.2: DYNAMICS

The student will be able to:

S3P-3-08: Identify the four fundamental forces of nature.

S3P-3-09: Perform an experiment to demonstrate Newton’s Second Law

S3P-3-10: Define the unit of force as the Newton.

S3P-3-11: Define as the vector sum of all forces acting on a body.
Include: *force of friction, normal force, gravitational force, applied forces*

S3P-3-12: Construct free-body diagrams to determine the net force for objects in various situations.
Include: *balanced and unbalanced forces, inclined planes*

S3P-3-13: Solve problems, using Newton’s Second Law and the kinematics equations from S3P-3-07.
Include: *forces applied along a straight line and perpendicular forces*

13 OUTCOMES

TOPIC 4.1: GRAVITATIONAL FIELDS

Students define the gravitational force constant g as a force per unit mass in N/kg, and the weight as $F_g = mg$. The acceleration due to gravity (i.e., $a_g = g$) is derived from Newton's laws and determined in the laboratory. Students describe the normal force in terms of the mutual attraction of masses, and draw simple freebody diagrams.

The student will be able to:

S3P-4-01: Define the gravitational field qualitatively as the region of space around a mass where another point mass experiences a force.

S3P-4-02: Diagram the Earth's gravitational field, using lines of force.

S3P-4-03: Define the gravitational field quantitatively as a force per unit mass.

S3P-4-04: Compare and contrast the terms "mass" and "weight."

S3P-4-05: Describe, qualitatively and quantitatively, apparent weight changes in vertically accelerating systems.
Examples: *elevators, spacecraft…*

S3P-4-06: Derive the acceleration due to gravity from free fall and Newton's laws.

S3P-4-07: Perform an experiment to calculate g near the surface of the Earth.

S3P-4-08: Solve free-fall problems.

S3P-4-09: Describe terminal velocity, qualitatively and quantitatively.

S3P-4-10: Define the coefficient of friction (μ) as the ratio of the force of friction and the normal force.

S3P-4-11: Distinguish between static and kinetic friction.

S3P-4-12: Compare the effects of the normal force, materials involved, surface area, and speed on the force of friction.

S3P-4-13: Solve problems with the coefficient of friction for objects on a horizontal surface.

TOPIC 4.2: ELECTRIC FIELDS

Students define the electric field strength, E, as a force per unit charge (in N/C). The electric force is given by $F_e = qE$, and lines of force are used to draw the field. The field between two parallel plates is described. Students examine problems involving both the gravitational and electric forces, and describe Millikan's experiment and the elementary charge.

The student will be able to:

S3P-4-14: Define the electric field qualitatively as the region of space around a charge where a positive test charge experiences a force.

S3P-4-15: Diagram electric fields using lines of force with respect to a positive test charge.
Include: *single point charges (positive and negative), near two like charges, near two* unlike charges, between a single charge and a charged plate, between two oppositely charged parallel plates

S3P-4-16: Define the electric field quantitatively as a force per unit charge ($E = \frac{F}{q}$) and solve problems using the unit field concept ($F = qE$).

S3P-4-17: Solve problems for the motion of charges between parallel plates where $F_{net} = F_e + F_g$.

S3P-4-18: Describe a simplified version of Millikan's experiment for the determination of the elementary charge (solve for charge when $F_e = F_g$.

S3P-4-19: Define the elementary charge and convert between elementary charges and coulombs.
Include: $q = Ne$

TOPIC 4.3: MAGNETIC FIELDS

The student will be able to:

S3P-4-20: Define the magnetic field as the region of space around a magnet where another magnet will experience a force.

S3P-4-21: Demonstrate and diagram magnetic fields, using lines of force.
Include: *bar magnet, horseshoe magnet, between like poles, between unlike poles*

S3P-4-22 Describe the concept of magnetic poles and demonstrate that like poles repel and unlike poles attract.

S3P-4-23: Describe magnetism, using the domain theory.
Include: *ferromagnetic materials, the attraction of iron objects to north and south poles*

S3P-4-24: Investigate the influence and effects of the magnetic field of the Earth.
Include: *auroras, magnetic declination and inclination*

TOPIC 4.4: ELECTROMAGNETISM

The student will be able to:

S3P-4-25: Describe and demonstrate the phenomenon of electromagnetism.

S3P-4-26: Diagram and describe qualitatively the magnetic field around a current-carrying wire.
Include: *direction and intensity of the field*

S3P-4-27: Diagram and describe qualitatively the magnetic field of a solenoid.
Include: *direction and intensity of the field*

S3P-4-28: Describe and demonstrate the function of an electromagnet.
Include: *common applications of electromagnets*

S3P-4-29: Perform a lab to demonstrate that $B \propto I$ for an electromagnetic field.

S3P-4-30: Describe the force on a current-carrying conductor in a magnetic field.
Include: $F_B = IBlsin\theta$

S3P-4-31: Define the magnetic field quantitatively as a force per unit current element (i.e. $B = \frac{F_B}{Il}$, where Il is a current element).

S3P-4-32: Solve problems, using $F_B = IBl$.

32 OUTCOMES

115 OUTCOMES TOTAL

Skills and Attitudes Outcomes

Nature of Science

S3P-0-1a Explain the roles of theory, evidence, and models in the development of scientific knowledge.

S3P-0-1b Describe the importance of peer review in the evaluation and acceptance of scientific theories, evidence, and knowledge claims.

S3P-0-1c Relate the historical development of scientific ideas and technology to the form and function of scientific knowledge today.

S3P-0-1d Describe how scientific knowledge changes as new evidence emerges and/or new ideas and interpretations are advanced.

S3P-0-1e Differentiate between how scientific theories explain natural phenomena and how scientific laws identify regularities and patterns in nature.

Inquiry Skills

S3P-0-2a Select and use appropriate visual, numeric, graphical, and symbolic modes of representation to identify and represent relationships.

S3P-0-2b Propose problems, state hypotheses, and plan, implement, adapt, or extend procedures to carry out an investigation where required.

S3P-0-2c Formulate operational definitions of major variables or concepts.

S3P-0-2d Estimate and measure accurately, using Système International (SI) units.

S3P-0-2e Evaluate the relevance, reliability, and adequacy of data and datacollection methods.
Include: *discrepancies in data and sources of error*

S3P-0-2f Record, organize, and display data, using an appropriate format.
Include: *labelled diagrams, tables, graphs.*

S3P-0-2g Interpret patterns and trends in data, and infer or calculate linear relationships among variables.

S3P-0-2h Analyze problems, using vectors.
Include: *adding and subtracting vectors in straight lines and at right angles, vector components*

S3P-0-2i Select and integrate information obtained from a variety of sources.
Include: *print, electronic, and/or specialist sources, resource people.*

Science, Technology, Society, and the Environment (STSE)

S3P-0-3a Analyze, from a variety of perspectives, the risks and benefits to society and the environment when applying scientific knowledge or introducing technology.

S3P-0-3b Describe examples of how technology has evolved in response to scientific advances, and how scientific knowledge has evolved as a result of new innovations in technology.

S3P-0-3c Identify social issues related to science and technology, taking into account human and environmental needs and ethical considerations.

S3P-0-3d Use the decision-making process to address an STSE issue.

S3P-0-3e Identify a problem, initiate research, and design a technological or other solution to address the problem.

Attitudes

S3P-0-4a Demonstrate work habits that ensure personal safety, the safety of others, and consideration of the environment.

S3P-0-4b Work cooperatively with a group to identify prior knowledge, initiate and exchange ideas, propose problems and their solutions, and carry out investigations.

S3P-0-4c Demonstrate confidence in carrying out scientific investigations and in addressing STSE issues.

S3P-0-4d Develop a sense of personal and shared responsibility for the impact of humans on the environment, and demonstrate concern for social and environmental consequences of proposed actions.

S3P-0-4e Demonstrate a continuing and more informed interest in science and science-related issues.

S3P-0-4f Value skepticism, honesty, accuracy, precision, perseverance, and open-mindedness as scientific and technological habits of mind.

25 OUTCOMES