Unit 5: Modern Physics

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Title Section

Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

Unit 5

Modern Physics

Belleville Board of Education

102 Passaic Avenue

Belleville, NJ 07109

Prepared by:

Dr. Richard Tomko, Superintendent of Schools

Mr. Thomas D'Elia, Director of Curriculum and Instruction

Ms. Diana Kelleher, District Supervisor of ELA/Social Studies

Mr. George Droste, District Supervisor of Math/Science

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Unit Overview

In this unit, students will be introduced to the world through the eyes of a physicist, whose principle goal is to study the underlying nature of everyday processes and to investigate the structure of the universe in terms of scientific analysis. Using the sciences of kinematics, or study of motion, and dynamics, or the study of forces, this unit requires the students to put into practice previously learned skills of hypothesis creation, experimental design, data collection and analysis in order to investigate how objects move through space. The quantities to be investigated include base units such as mass, length, and time, as well as derived units such as velocity and acceleration. The interrelation of these quantities will be discussed and problems will be solved using kinematics formulas. In addition, Newton's Laws of Motion will be used to analyze changes in motion. Finally, students will be introduced to the idea of energy, its influence on motion, and how forces can be used to manipulate energy.

NJSLS

SEP.1	Asking Questions and Defining Problems
CCC.2	Cause and effect: Mechanism and explanation.
CCC.4	Systems and system models.
CCC.7	Stability and change.
SEP.5	Using Mathematics and Computational Thinking
SEP.7	Engaging in Argument from Evidence

SEP.8	Obtaining, Evaluating, and Communicating Information
SCI.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
SCI.HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
SCI.HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
SCI.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
SCI.HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
SCI.HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
SCI.HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
SCI.HS-PS3-5	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
SCI.HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
SCI.HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

Exit Skills

By the end of Unit 5 Students will:

1. Describe thermal energy and compare it to potential and kinetic energies.
2. Distinguish temperature from thermal energy.
3. Define specific heat.
4. Calculate heat transfer.
5. Define heats of fusion and vaporization.
6. State the first and second laws of thermodynamics.
7. Distinguish between heat and works.
8. Define entropy.
9. Compare gasses and plasma.
10. Explain how cohesive forces cause surface tension.
11. Explain how adhesive forces cause capillary action.
12. Discuss evaporative cooling and the role of condensation in cloud formation.
13. Relate the properties of solids to their structures.
14. Explain why solids expand when the temperature changes.
15. Calculate the expansion of solids.
16. Explain the importance of thermal expansion.
17. Describe the spectrum emitted by a hot body.

18. Explain the photoelectric and Compton effects.
19. Solve problems involving the photoelectric effect.
20. Describe evidence of the wave nature of matter.
21. Solve problems involving the de Broglie wavelength of particles.
22. Describe the dual nature of waves and particles, and the importance of the Heisenberg uncertainty principle.
23. Describe the structure of the nuclear atom.
24. Compare and contrast continuous spectra and line-emission spectra.
25. Solve problems using orbital-radius and energy level equations.
26. Describe the shortcomings of Bohr's atomic model.
27. Describe the quantum model of the atom.
28. Explain how a laser works.
29. Describe the properties of laser light.
30. Describe electron motion in conductors and semiconductors.
31. Compare and contrast n-type and p-type semiconductors.
32. Describe how diodes limit current to motion in only one direction.
33. Explain how a transistor can amplify or increase voltage changes.
34. Determine the number of neutrons and protons in nuclides.
35. Define the binding energy of the nucleus.
36. Relate the energy released in a nuclear reaction to the change in binding during the reaction.
37. Describe three forms of radioactive decay.
38. Solve nuclear equations.
39. Calculate the amount remaining and the activity of radioactive material after a given time.
40. Define nuclear fission and fusion.
41. Describe the operation of a nuclear reactor.
42. Describe the operation of particle accelerators and particle detectors.
43. Describe the standard model of matter and explain the role of force carriers

Enduring Understanding

Unit Eduring Understandings:

Objects and systems have properties such as mass and charge. Systems may have internal structure.
Fields existing in space can be used to explain interactions.
Changes that occur as a result of interactions are constrained by conservation laws.
Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.
The mathematics of probability can be used to describe the behavior of complex systems and to interpret the behavior of quantum mechanical systems.
There isphysical evidence for the structure of the atom.
Life on earth is sustained by nuclear fusion reactions within the sun
Radioactivity is not a rare occurrence on our planet.
Radioactive elements decay at predictable rates defined by the half-life

Definition: ***Enduring Understandings***

Enduring understandings are statements summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom. They synthesize what students should understand—not just know or do—as a result of studying a particular content area. Moreover, they articulate what students should "revisit" over the course of their lifetimes in relationship to the content area.

Enduring understandings:

1. Frame the big ideas that give meaning and lasting importance to such discrete curriculum elements as facts and skills
2. Can transfer to other fields as well as adult life
3. "Unpack" areas of the curriculum where students may struggle to gain understanding or demonstrate misunderstandings and misconceptions
4. Provide a conceptual foundation for studying the content area and
5. Are deliberately framed as declarative sentences that present major curriculum generalizations and recurrent ideas.

Example:

Reading/Literature

This is an Enduring Understanding

Reading is a process by which we construct meaning about the information being communicated by an author within a print or non-print medium.

This is an Essential Question

How is reading a process of constructing meaning from text?

Essential Questions

Unit Essential Questions:

In what ways were misconceptions in physics corrected by modern physicists
How do physicists currently view the nature of the universe?
What are the current gaps in understanding?
What behavior is exhibited by particles on the atomic scale?
How is the nucleus affected during various nuclear reactions?
How do LEDs/Lasers work?
Why are only certain transitions between energy states of the atom allowed?

How can you predict how certain atoms will combine to form compounds?
Why do nuclear reactions involve huge amounts of energy?
Are all forms of radiation dangerous?

Essential Question: A question that lies at the heart of a subject or a curriculum and one that promotes inquiry and the discovery of a subject.

•They can help students discover patterns in knowledge and solve problems.
•They support inductive teaching—guiding students to discover meaning, which increases motivation to learn.
•They are one of the most powerful tools for helping students think at more complex levels.
•They engage the personal intellect—something that traditional objectives usually fail to do.
•Have no obvious "right" answer
•Raise other important questions, often across subject-area boundaries
•Address a concept
•Raise other important questions
•Naturally and appropriately recur
•Stimulate critical, ongoing rethinking
•Are framed to provoke and sustain student interest

What makes a Questions "Essential?"
•Continues throughout all our lives
•Refers to core ideas and inquiries within a discipline
•Helps students effectively ask questions and make sense of important and complex ideas, knowledge, and know-how
•Engages a specific and diverse set of learners

Two Types of Essential Questions:
•Overarching: The overall "Big Idea"
    •More general, broader
    •Point beyond specific topics or skills
    •Promote the transfer of understanding

•Topical: Unit or lesson specific but still promotes inquiry
    •Unit or lesson specific - used to guide individual units or lessons
    •Promote inquiry
    •Resist obvious answers
    •Require explanation and justification

Examples:
•What is a true friend?
•What makes an artist amazing?
•In what sense is the body a system?
•What is the law of nature, and how is it like or unlike social laws?
•To what extent is US history a history of progress?
•In what ways do diet and exercise affect health?
•Must heroes be flawless?
•How do effective writers hook and hold their readers?

•How do cultures affect one another?
•Does practice make perfect?
•What is healthy eating? Healthy living?
•How and when do we use mathematics?
•How does something acquire value?

Learning Objectives

The student will be able to...

Describe the spectrum emitted by a hot body.
Explain the photoelectric and Compton effects.
Solve problems involving the photoelectric effect.
Describe evidence of the wave nature of matter.
Solve problems involving the de Broglie wavelength of particles.
Describe the dual nature of waves and particles, and the importance of the Heisenberg uncertainty principle.
Describe thermal energy and compare it to potential and kinetic energies.
Distinguish temperature from thermal energy.
State the first and second laws of thermodynamics.
Distinguish between heat and work.
Define entropy.
Describe the structure of the nuclear atom.
Compare and contrast continuous spectra and line emission spectra.
Solve problems using orbital-radius and energy level equations.
Describe the shortcomings of Bohr's atomic model.
Describe the quantum model of the atom.
Explain how a laser works.
Describe the properties of laser light.
Determine the number of neutrons and protons in nuclides.
Define the binding energy of the nucleus.
Relate the energy released in a nuclear reaction to the change in binding during the reaction.
Describe three forms of radioactive decay.
Solve nuclear equations.
Calculate the amount remaining and the activity of radioactive material after a given time. Define nuclear fission and fusion.
Describe the operation of a nuclear reactor.
Describe the operation of particle accelerators and particle detectors.
Describe the standard model of matter and explain the role of force carriers.

Tips on Writing Good Learning Objectives

Bloom's Taxonomy

Applying Bloom's Taxonomy to Learning Objectives

Effective learning objectives need to be observable and/or measureable, and using action verbs is a way to achieve this. Verbs such as "identify", "argue," or "construct" are more measureable than vague or passive verbs such as "understand" or "be aware of". As you develop your syllabus focus on articulating clear learning objectives and then use these objectives to guide class assignments, exams and overall course assessment questions.

Sample Learning Objectives for a Lower Division Course

After completing Nutrition 101 *Humans and Food*, students will be able to:

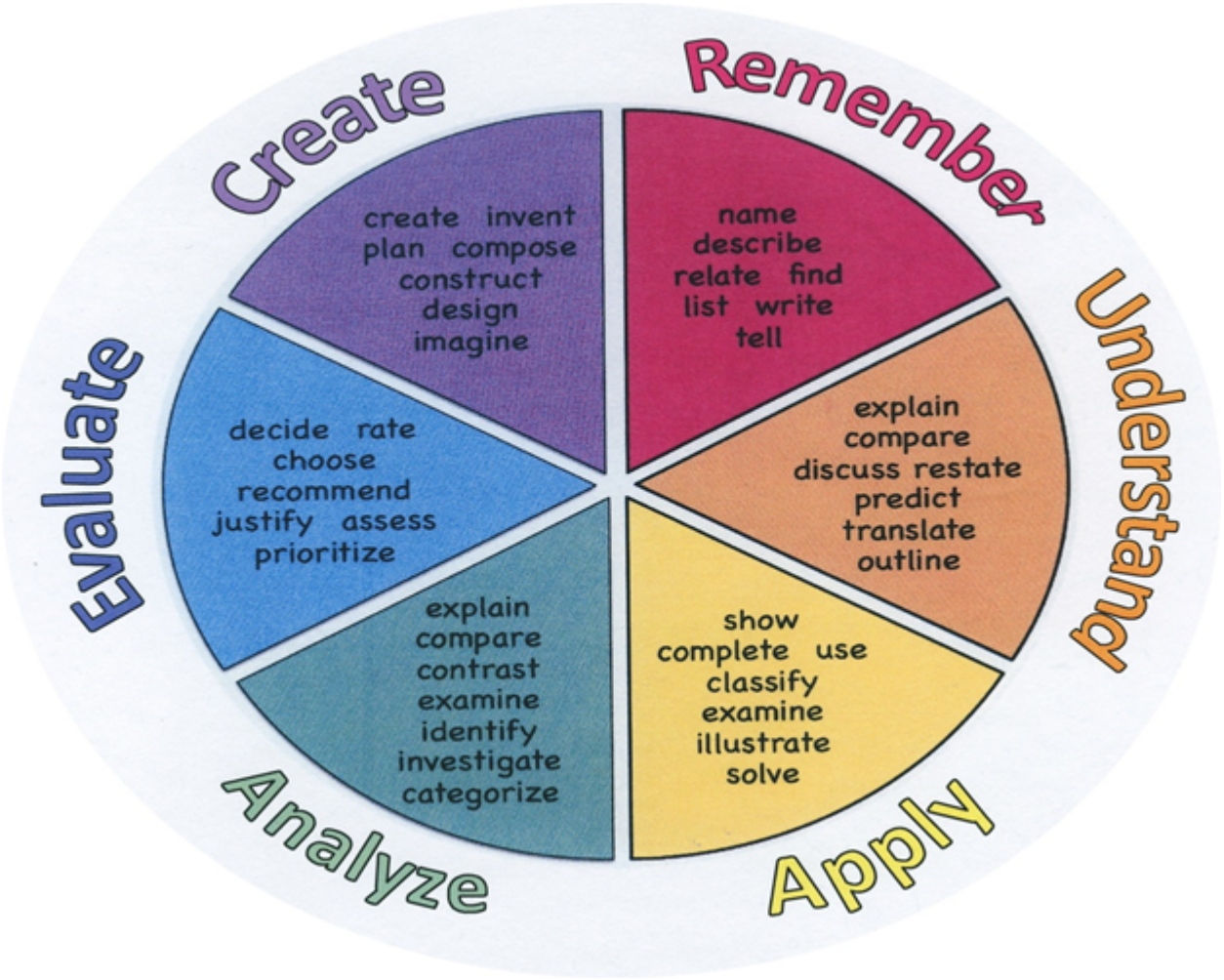
- **Identify** nutrients found in common food sources via the product's nutrition label
- Use computer dietary analysis to assess a 2-day dietary intake and **summarize** results
- **Locate** nutrition-related information on the Internet and use **evaluative** criteria to **identify** reliability of the information

Action Verbs

Below are examples of action verbs associated with each level of the Revised Bloom's Taxonomy. These are useful in writing learning objectives, assignment objectives and exam questions.

Remember	Understand	Apply	Analyze	Evaluate	Create
Choose	Classify	Choose	Categorize	Appraise	Combine
Describe	Defend	Dramatize	Classify	Judge	Compose
Define	Demonstrate	Explain	Compare	Criticize	Construct
Label	Distinguish	Generalize	Differentiate	Defend	Design
List	Explain	Judge	Distinguish	Compare	Develop
Locate	Express	Organize	Identify	Assess	Formulate
Match	Extend	Paint	Infer	Conclude	Hypothesize
Memorize	Give Examples	Prepare	Point out	Contrast	Invent
Name	Illustrate	Produce	Select	Critique	Make
Omit	Indicate	Select	Subdivide	Determine	Originate
Recite	Interrelate	Show	Survey	Grade	Organize
Select	Interpret	Sketch	Arrange	Justify	Plan
State	Infer	Solve	Breakdown	Measure	Produce
Count	Match	Use	Combine	Rank	Role Play
Draw	Paraphrase	Add	Detect	Rate	Drive
Outline	Represent	Calculate	Diagram	Support	Devise
Point	Restate	Change	Discriminate	Test	Generate
Quote	Rewrite	Classify	Illustrate		Integrate
Recall	Select	Complete	Outline		Prescribe
Recognize	Show	Compute	Point out		Propose
Repeat	Summarize	Discover	Separate		Reconstruct
Reproduce	Tell	Divide			Revise
	Translate	Examine			Rewrite
	Associate	Graph			Transform
	Compute	Interpolate			
	Convert	Manipulate			
	Discuss	Modify			
	Estimate	Operate			
	Extrapolate	Subtract			

	Generalize Predict				



Interdisciplinary Connections

Please list all and any cross-curricular content standards that link to this Unit.

MA.K-12.2	Reason abstractly and quantitatively.
MA.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
MA.K-12.4	Model with mathematics.
MA.A-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

LA.RST.11-12.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
LA.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
MA.A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
LA.WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
LA.SL.11-12.4	Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
LA.SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Alignment to 21st Century Skills & Technology

Key SUBJECTS AND 21st CENTURY THEMES

Mastery of key subjects and 21st century themes is essential for all students in the 21stcentury.

Key subjects include:

- English, reading or language arts
- World languages
- Arts
- Mathematics
- Economics
- Science
- Geography
- History
- Government and Civics

21st Century/Interdisciplinary Themes

- Civic Literacy
- Environmental Literacy

- Financial, Economic, Business and Entrepreneurial Literacy
- Global Awareness
- Health Literacy

21st Century Skills

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

Technology Infusion

What technology can be used in this unit to enhance learning?



Differentiation

As a Reminder:

The basis of good differentiation in a lesson lies in differentiating by content, process, and/or product.

Resources:

- NJDOE: Instructional Supports and Scaffolds for Success in Implementing the Common Core State Standards http://www.state.nj.us/education/modelcurriculum/success/math/k2/

Special Education

- printed copy of board work/notes provided
- additional time for skill mastery
- assistive technology
- behavior management plan
- Center-Based Instruction
- check work frequently for understanding
- computer or electronic device utilizes
- extended time on tests/ quizzes
- have student repeat directions to check for understanding
- highlighted text visual presentation
- modified assignment format
- modified test content
- modified test format
- modified test length
- multi-sensory presentation
- multiple test sessions
- preferential seating
- preview of content, concepts, and vocabulary
- reduced/shortened reading assignments
- Reduced/shortened written assignments
- secure attention before giving instruction/directions
- shortened assignments
- student working with an assigned partner
- teacher initiated weekly assignment sheet
- Use open book, study guides, test prototypes

ELL

- teaching key aspects of a topic. Eliminate nonessential information

- using videos, illustrations, pictures, and drawings to explain or clarif
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning;
- allowing students to correct errors (looking for understanding)
- allowing the use of note cards or open-book during testing
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher's notes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using computer word processing spell check and grammar check features
- using true/false, matching, or fill in the blank tests in lieu of essay tests

Intervention Strategies

- allowing students to correct errors (looking for understanding)
- teaching key aspects of a topic. Eliminate nonessential information
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning
- allowing students to select from given choices
- allowing the use of note cards or open-book during testing
- collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test.
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher's notes
- marking students' correct and acceptable work, not the mistakes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using authentic assessments with real-life problem-solving
- using true/false, matching, or fill in the blank tests in lieu of essay tests
- using videos, illustrations, pictures, and drawings to explain or clarify

Evidence of Student Learning-CFU's

Please list ways educators may effectively check for understanding in this secion.

- Admit Tickets
- Anticipation Guide
- Common benchmarks
- Compare & Contrast
- Create a Multimedia Poster
- Define
- Describe
- Evaluate
- Evaluation rubrics
- Exit Tickets
- Explaining
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Newspaper Headline
- Outline
- Question Stems
- Quickwrite
- Quizzes
- Red Light, Green Light
- Self- assessments
- Socratic Seminar
- Study Guide
- Teacher Observation Checklist
- Think, Pair, Share
- Think, Write, Pair, Share
- Top 10 List
- Unit tests

Primary Resources

Textbook

Internet

Science Department Video Library

Ancillary Resources

Teacher Prepared Materials

Lab Materials

Study Guide Materials

United Streaming Videos

The Physics Classroom: www.thephysicsclassroom.com

STEM Lab

Sample Lesson

One Lesson per Curriculum must bein this lesson plan template. I.e. one lesson in one unit

Unit Name:

NJSLS:

Interdisciplinary Connection:

Statement of Objective:

Anticipatory Set/Do Now:

Learning Activity:

Student Assessment/CFU's:

Materials:

21st Century Themes and Skills:

Differentiation/Modifications:

Integration of Technology: