Forensic Physics
Curriculum

Grades 11-12

Vineland Public Schools
Vineland, New Jersey

Vineland Board of Education

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Vineland Public Schools Mission Statement

The mission of the Vineland Public Schools is based upon the conviction that all students can learn. This is based upon their exposure to curriculum and instruction that addresses the New Jersey Core Curriculum Content Standards (NJCCCS) at all grade levels. We recognize that learning is the result of a strong partnership of parents, teachers and community, as students are challenged to become active participants in the quest for excellence.

Our goal is to ensure a safe, creative, stimulating and caring environment, which promotes self-esteem, sound character, responsibility and respect for diversity. This will enable students to become knowledgeable, skillful, life-long learners who are contributing citizens in our changing society.

We expect the best from our students and will give no less of ourselves.

Course Description

Forensic Physics is the application of science to law. This curriculum applies scientific knowledge to identify the proper techniques needed to solve problems. The role of this course will be to instruct students in how to relate their scientific ability, learned in their previous science courses, in order to supply accurate information that reflects the events that have occurred at a crime scene.

The course will provide each student with:

- An understanding of the justice system as it relates to Forensics
- Instruction in how to search a crime scene for physical evidence
- How to follow proper techniques for the collection and preservation of physical evidence
- The ability to apply knowledge and understanding of the class material, in presenting expert witness testimony about the crime scene and physical evidence.

The Forensic Physics course will be structured as a regular science course. The course will include: lectures; oral presentations; projects; laboratory activity; **with special attention to safety;** open discussions of crime scenes; guest speakers; and field trips. Self-discipline and organizational skills will be common practice. Use of computer technology and diverse scientific equipment will reinforce the knowledge acquired during the year. This course is designed for students who have a serious interest in pursuing a career in Forensics or related fields.

Course Goals

The student will:

1. Review previous math knowledge in order to apply it to the information given in this course.
2. Relate forensic science to the criminal justice systems.
3. Understand the legal connection between forensic physics and the logistics of the state of New Jersey.
4. Understand the responsibility of police officers arriving at the crime scene.
5. Know how to handle evidence and properly search a crime scene.
6. Explain the purpose physical evidence plays in reconstructing the crime scene.
7. Review basic Chemistry concepts as they apply to forensics.
8. Study the behavior of light as it applies to the investigation of a crime scene.
9. Recognize the relationship between psychological processes and physical behavior.
10. Discuss commonly abused drugs and be able to perform routine laboratory tests such as chromatography.
11. Explain the significance of alcohol concentration in the blood as it relates to law enforcement and forensic toxicology.
12. Be able to operate and understand the functions of an electron microscope.
13. List and describe forensic tests used to classify blood, chromosomes, and genes. Explain how they are linked to DNA.
14. Demonstrate proper collection of forensic hair evidence.
15. Study the atomic structure, isotopes, and radioactive elements as they relate to light, energy, and spectrograph emission.
16. Define combustion and explain the mechanism of heat transfer.
17. Classify different types of explosives and how they are collected at the scene of the crime.
18. Study the basic principles related to finger-printing and their use in criminal investigations.
19. Study trajectories and identify different types of projectiles.
20. Analyze traces such as foot prints and other impressions.
21. Compare and contrast hand writing or print in order to identify the source and/or authenticity of a document.
22. Interpret and analyze computer data.
23. Distinguish between read only memory and random access memory.
24. Recall internet knowledge and learn how to retrieve information related to forensic science.

NJ Core Content Curriculum Standards and Cumulative Progress Indicators

STANDARD 5.1 (Scientific Processes) All students will develop problem-solving, decision-making and inquiry skills, reflected by formulating usable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions, and communicating results.

Strands and Cumulative Progress Indicators

Building upon knowledge and skills gained in preceding grades, by the end of **Grade 12**, students will:

A. Habits of Mind

1. When making decisions, evaluate conclusions, weigh evidence, and recognize that arguments may not have equal merit.
2. Assess the risks and benefits associated with alternative solutions.
3. Engage in collaboration, peer review, and accurate reporting of findings.
4. Explore cases that demonstrate the interdisciplinary nature of the scientific enterprise.

B. Inquiry and Problem Solving

1. Select and use appropriate instrumentation to design and conduct investigations.
2. Show that experimental results can lead to new questions and further investigations.

C. Safety

1. Understand, evaluate and practice safe procedures for conducting science investigations.

STANDARD 5.2 (Science and Society) All students will develop an understanding of how people of various cultures have contributed to the advancement of science and technology, and how major discoveries and events have advanced science and technology.

Strands and Cumulative Progress Indicators

Building upon knowledge and skills gained in preceding grades, by the end of **Grade 12**, students will:

B. Historical Perspectives

2. Discuss significant technological achievements in which science has played an important part as well as technological advances that have contributed directly to the advancement of scientific knowledge.

STANDARD 5.3 (Mathematical Applications) All students will integrate mathematics as a tool for problem-solving in science, and as a means of expressing and/or modeling scientific theories.

Strands and Cumulative Progress Indicators

Building upon knowledge and skills gained in preceding grades, by the end of **Grade 12**, students will:

B. Geometry and Measurements

1. When performing mathematical operations with measured quantities, express answers to reflect the degree of precision and accuracy input data.

C. Patterns and Algebra

1. Apply mathematical models that describe physical phenomena to predict real world events.

STANDARD 5.4 (Nature and Process of Technology) All students will understand the interrelationships between science and technology and develop a conceptual understanding of the nature and process of technology.

Strands and Cumulative Progress Indicators

Building upon knowledge and skills gained in preceding grades, by the end of **Grade 12**, students will:

A. Science and Technology

1. Know that scientific inquiry is driven by the desire to understand the naturally world and seeks to answer question that may or may not directly influence humans, while technology is driven by the need to meet human needs and solve human problems.

B. Nature of Technology

1. Assess the impacts of introducing a new technology in terms of alternative solutions, costs, tradeoffs, risks, benefits and environmental impact. .

STANDARD 5.5 (Characteristics of Life) All students will gain an understanding of the structure, characteristics, and basic needs of organisms and will investigate the diversity of life.

Strands and Cumulative Progress Indicators

Building upon knowledge and skills gained in preceding grades, by the end of **Grade 12**, students will:

A. Matter, Energy, and Organization in Living Systems

1. Relate the structure of molecules to their function in cellular structure and metabolism.

B. Diversity and Biological Evolution

2. Explain how the theory of natural selection accounts for extinction as well as an increase in the proportion of individuals with advantageous characteristics within a species.

C. Reproduction and Heredity

1. Describe how information is encoded and transmitted in genetic material.

3. Assess the impact of current and emerging technologies on our understanding of inherited human characteristics.

STANDARD 5.6 (Chemistry) All students will gain an understanding of the structure and behavior of matter.

Strands and Cumulative Progress Indicators

Building upon knowledge and skills gained in preceding grades, by the end of **Grade 12**, students will:

A. Structure and Properties of Matter

1. Know that atoms are made of a positive nucleus surrounded by negative electrons and that the nucleus, a tiny fraction of the volume of an atom, is composed of protons and neutrons, each almost 2,000 times more massive than an electron.

5. Explain how the Periodic Table of Elements reflects the relationship between the properties of elements and their atomic structure.
6. Know that many biological, chemical and physical phenomena can be explained by changes in the arrangement and motion of atoms and molecules.
7. Recognize that the properties of matter are related to the structure and arrangement of their molecules and atoms, such as in metallic and nonmetallic crystals and carbon compounds.
8. Know that different levels of energy of an atom are associated with different configurations of its electrons.

B. Chemical Reactions

1. Explain that the rate of reactions among atoms and molecules depends on how often they encounter one another and that the rate is affected by nature of reactants, concentration, pressure, temperature, and the presence of a catalyst.

2. Show that some changes in chemical bonds require a net input or net release of energy.

STANDARD 5.7 (Physics) All students will gain an understanding of natural laws as they apply to motion, forces, and energy transformations.

Strands and Cumulative Progress Indicators

Building upon knowledge and skills gained in preceding grades, by the end of **Grade 12**, students will:

A. Motion and Forces

1. Apply the mathematical relationship between the mass of an object, the net force exerted on it, and the resulting acceleration.

B. Energy Transformations

1. Explain how the various forms of energy (heat, electricity, sound, light) move through materials and identify the factors that affect that movement.
2. Explain that while energy can be transformed from one form to another, the total energy of a closed system is constant.

4. Recognize that electrically charged bodies can attract or repel each other with a force that depends upon the size and nature of the charges and the distance between them and know that electric forces play an important role in explaining the structure and properties of matter.

Objectives

The student will be able to:

I. Review and introduction

1. Recognize proper units of the metric system as it applies to different variables. (CCS 5.3.12.C.1)
2. Evaluate basic algebraic equations and be able to replace variables. (CCS 5.3.12.C.1)
3. Review concepts such as area, volume, density, specific gravity, center of mass, and weight. (CCS 5.3.12.b.1)
4. Understand the safety rules of the classroom as they apply to laboratory work. (CCS 5.1.12.C.1)
5. Identify all the parts of the microscope and understand its use. (CCS 5.1.12.B.1)
6. Describe the scientific method using simple examples. (CCS 5.1.12.A.4)
7. Define and differentiate between forensic science and criminal law. (CCS 5.1.12.A.4)
8. Recognize the historical background related to the development to forensic science. (CCS 5.2.12.B.2)
9. Understand the need for the growth of forensic laboratories in our chaotic society. (CCS 5.2.12.B.2)
10. Explain the connection between the services between the services of the criminal laboratory and the criminal justice system. (CCS 5.1.12.A.4)
11. Investigate past legal cases to learn the relationship between scientific evidence presented, and the outcome of the court rulings. (CCS 5.1.12.A.4)
12. Define the roll and responsibility of an expert witness. (CCS 5.1.12.A.4)
13. Study and analyze the logistics of the state of New Jersey; as they apply to the study of forensic evidence. (CCS 5.1.12.A.4)

II. The crime scene

14. Define physical evidence. (CCS 5.1.12.B.1)
15. Discuss the importance and responsibility of the first police officer arriving at the crime scene. (CCS 5.1.12.A.3)
16. Give detailed explanations of the procedures followed during the search of the crime scene for physical evidence. (CCS 5.1.12.A.1)
17. Learn proper techniques for the preservation and packing of different types of physical evidence. (CCS 5.1.12.A.2)
18. Define the concept of “chain of custody”. (CCS 5.1.12.A.4)

III. Physical evidence

19. Classify physical evidence found at a crime scene. (CCS 5.1.12.A.4)
20. Recognize and understand differences between identification of physical evidence, and comparative study of physical evidence. (CCS 5.1.12.A.4)
21. Understand the importance and value of properly preserved evidence as it relates to a criminal investigation. (CCS 5.1.12.B.1)
22. Make proper use of national databases that are available to forensic scientists. (CCS 5.1.12.B.1)

23. Relate physical evidence to the reconstruction of the events surrounding the crime. (CCS 5.1.12.B.2)

IV. Properties of matter and the analysis of glass

24. Define the physical and chemical properties of matter. (CCS 5.6.12.A.7)
25. Apply proper units of the metric system each definition. (CCS 5.1.12.C.1)
26. Differentiate between elements and compounds. (CCS 5.6.12.A.6)
27. Analyze properties of solids, liquids and gases. (CCS 5.6.12.A.7)
28. Define density and understand Archimedes principle and force of buoyancy. (CCS 5.7.12.A.1)
29. Understand Snell's law, and the index of refraction. (CCS 5.7.12.B.1)
30. Explain the phenomenon of dispersion as it applies to a prism, and differences in wavelengths of the light spectrum. (CCS 5.7.12.B.1)
31. Identify the electromagnetic spectrum by wavelength and frequency. (CCS 5.7.12.B.4)
32. Understand the dual theory of light. (CCS 5.7.12.B.4)
33. Determine the steps to explain the forensic method for analyzing glass fragments. (CCS 5.1.12.A.4)
34. Explain how to examine glass fractures to determine the direction of impact from a projectile. (CCS 5.7.12.A.1)
35. Describe the proper method of collection and preservation of glass evidence. (CCS 5.1.12.A.4)

V. Drugs

36. Differentiate between psychological and physical addiction. (CCS 5.1.12.A.4)
37. Name and classify commonly abused drugs. (CCS 5.1.12.A.4)
38. Describe common laboratory tests that are used to identify commonly abused drugs. (CCS 5.1.12.B.1)
39. Describe the process of chromatography which uses color to identify drugs. (CCS 5.7.12.B.1)
40. Differentiate between gas chromatography and thin layer chromatography. (CCS 5.7.12.B.1)
41. Identify organic compounds using ultraviolet and infrared light. (CCS 5.7.12.B.4)
42. Understand the use of mass spectrometry in the identification and analysis of a substance. (CCS 5.7.12.B.1)
43. Explain the proper collection and preservation of drug evidence. (CCS 5.1.12.A.4)

VI. Forensic toxicology

44. Explain how alcohol is processed throughout the body and excreted from the body. (CCS 5.6.12.B.1)
45. Understand different methods of alcohol testing that is done by authorities. (CCS 5.1.12.A.4)
46. Know the procedure for measuring alcohol content in the blood and the proper steps to preserve blood in order to analyze its alcohol level. (CCS 5.1.12.A.4)
47. Study the Schmerber vs. California case and understand its importance in the forensic field. (CCS 5.1.12.A.4)

48. Differentiate between forensic toxicology techniques to identify drugs and poisons. (CCS 5.6.12.B.2)
49. Understand the importance of obtaining samples of drugs or poisons in human tissue in assessing your case. (CCS 5.1.12.B.2)

VII. The microscope

50. List the parts of a microscope and their function. (CCS 5.1.12.B.1)
51. Contrast between a compound microscope and a stereoscopic microscope. (CCS 5.1.12.B.1)
52. Understand the use of a polarizing microscope to analyze light. (CCS 5.1.12.B.1)
53. Analyze the use of a micro spectrophotometer in the examination of traces of physical evidence. (CCS 5.1.12.B.1)
54. Compare the image formation mechanism of a light microscope to that of a scanning electron microscope. (CCS 5.4.12.A.1)
55. Outline the uses and applications of the scanning electron microscope in the forensics field. (CCS 5.4.12.A.1)

VIII. Forensic serology

56. Understand how whole blood is typed as A, B, AB and O. (CCS 5.5.12.B.2)
57. Describe forensic tests used to identify a stain of blood. (CCS 5.1.12.B.1)
58. Define antigen, antibody, chromosomes, and genes. Relate them to the identification of species and drugs. (CCS 5.5.12.C.1)
59. Study the Punnett square and its use to determine genotypes and phenotypes of offspring. (CCS 5.5.12.C.1)
60. Explain laboratory tests and proper preservation needed to characterize seminal stains and blood stains. (CCS 5.1.12.A.4)
61. Understand steps to follow in the collection of physical evidence in a rape investigation. (CCS 5.1.12.A.4)

IX. DNA: The indispensable forensic science tool

62. Identify a DNA molecule, its parts and its double-helix structure. (CCS 5.5.12.C.1)
63. Understand the importance of DNA in the functioning of a human body. (CCS 5.5.12.C.1)
64. Explain the technology of polymerase chain reaction (PCR) and how it applies to forensic DNA typing. (CCS 5.5.12.C.3)
65. Contrast between PCR and STR's DNA typing technologies. (CCS 5.5.12.C.3)
66. Describe the difference between nuclear and mitochondrial DNA. (CCS 5.5.12.C.1)
67. Recognize the importance of DNA databases in a criminal investigation. (CCS 5.5.12.C.3)
68. List proper procedures for the preservation of biological evidence. (CCS 5.1.12.A.4)

X. Trace evidence I: Hairs and fibers

69. Define hair cuticle, cortex and medulla; and list the phases of hair growth. (CCS 5.5.12.A.1)
70. Differentiate between animal and human hair. (CCS 5.5.12.A.1)

71. Explain the proper collection of forensic hair evidence and list the features that are useful for microscopic analysis. (CCS 5.1.12.A.4)
72. Recognize the importance of DNA typing in the analysis of hair samples. (CCS 5.5.12.C.1)
73. Differentiate between natural and manufactured fibers. (CCS 5.6.12.A.7)
74. Study properties of fibers that are useful for forensic comparison, and the proper collection and preservation of fiber evidence. (CCS 5.6.12.A.7)

XI. Trace evidence II: Metals, paint and soil

75. Define protons, neutrons, electrons, atomic mass, atomic number, and isotopes. (CCS 5.6.12.A.1)
76. Describe the importance of trace elements in forensics. (CCS 5.1.12.A.4)
77. Understand proper collection and preservation of forensic paint and soil evidence. (CCS 5.1.12.A.4)
78. Study radioactive decay, and emission line spectra. (CCS 5.7.12.B.4)
79. Understand how the atom absorbs and releases energy in the form of light. (CCS 5.7.12.B.2)

XII. Forensic aspects of fire investigation

80. Define combustion and list the conditions necessary to maintain the process. (CCS 5.7.12.B.2)
81. Understand heat transfer and the laws of thermodynamics. (CCS 5.7.12.B.2)
82. Investigate the evidence, and recognize the signs, of an accelerant-initiated fire. (CCS 5.7.12.B.1)
83. Explain the process of physical evidence collection, related to a suspected arson crime scene. (CCS 5.1.12.A.4)
84. Know the laboratory procedures to detected and indentify hydrocarbon residue. (CCS 5.1.12.A.4)

XIII. Forensic investigation of explosives

85. Explain how explosives are classified. (CCS 5.6.12.A.7)
86. Understand how explosives can be created from some commercial products. (CCS 5.6.12.A.5)
87. Differentiate between initiating and non-initiating explosives. (CCS 5.7.12.B.2)
88. Describe how to collect and preserve evidence at a crime scene suspected of arson or explosion. (CCS 5.1.12.A.4)
89. List laboratory tests used to detect explosives. (CCS 5.1.12.B.1)

XIV. Fingerprints

90. Study the history of fingerprinting technology. (CCS 5.1.12.A.4)
91. Define ridge characteristics and there relation to human anatomy identification. (CCS 5.5.12.c.3)
92. List the three major finger print patterns and their sub classes. (CCS 5.1.12.A.4)
93. Differentiate between visible, plastic, and latent fingerprints. (CCS 5.1.12.A.4)
94. Understand the concept of AFIS (Automated fingerprint Identification System). (CCS 5.1.12.B.1)

95. Describe techniques used to identify fingerprints on different types of surfaces. (CCS 5.1.12.A.4)
96. Explain the use of digital imaging to enhance latent fingerprinting. (CCS 5.1.12.B.1)

XV. Firearms, tool marks, and other impressions

97. Explain the use of the comparison microscope, in the identification of bullets and cartridge cases. (CCS 5.1.12.B.1)
98. Distinguish between caliber and gauge. (CCS 5.1.12.B.1)
99. Explain the NIBIN data system. (National Integrated Ballistic Information Network) (CCS 5.1.12.B.1)
100. Study trajectories to determine distance from target or weapon, spread by bullet, and position of impact. (CCS 5.7.12.A.1)
101. List the laboratory tests used to identify the suspect that fired the weapon. (CCS 5.1.12.B.1)
102. List common field reagents used to enhance bloody finger prints. (CCS 5.6.12.B.1)
103. Explain forensic procedures used to investigate: tool mark; foot wear; and fire impression. (CCS 5.1.12.B.1)

XVI. Document examination

104. Define "questioned document". (CCS 5.1.12.A.4)
105. List common characteristics associated with hand writing. (CCS 5.1.12.A.4)
106. Explain the importance of following guidelines in the collection of written evidence; to avoid forgery. (CCS 5.1.12.A.4)
107. Determine the authenticity of a hand writing sample, or a document to be presented as forensic proof or evidence in court. (CCS 5.1.12.A.4)
108. Understand that hand writing evidence can be altered by the individual, or by the influence of drugs or alcohol. (CCS 5.1.12.A.4)
109. Describe the hardware and software component of a computer. (CCS 5.4.12.A.1)
110. Differentiate between read-only-memory and random-access-memory. (CCS 5.4.12.A.1)
111. Understand how a hard drive is partitioned. (CCS 5.4.12.A.1)

XVII. Computer forensics

112. List the areas of the computer that need to be examined to retrieve forensic data. (CCS 5.4.12.A.1)
113. Describe the proper procedure to preserve computer evidence from a crime scene. (CCS 5.4.12.A.1)
114. Understand the difference between the location of visible and latent data. (CCS 5.4.12.A.1)

XVIII. Forensic science and the internet

115. Recognize how the internet is structured. (CCS 5.4.12.A.1)
116. Know how to search for information on the internet, and how to retrieve information such as: mailing lists; news papers; and forensic science. (CCS 5.4.12.A.1)
117. Identify areas on the internet where a user's activity can be investigated. (CCS 5.4.12.A.1)

118. Explain how e-mails, chat, and instant messages can be traced and recovered. (CCS 5.4.12.A.1)
119. Identify three locations where the origin of a hacker can be traced. (CCS 5.4.12.A.1)

XIX. Careers in forensic science

120. Identify careers in forensics. (CCS 5.1.12.A.4)
121. Research College programs available in forensics. (CCS 5.1.12.A.4)
122. Recognize the need for scientific research and study in the forensic field. (CCS 5.4.12.B.1)

Learning Activities

1. A case study activity
2. Crime scene investigation: Deductive reasoning
3. Pressure and density lab
4. Crime scene sketching and digital photography
5. Forensic glass analysis
6. Optics: Mirrors and lenses lab
7. Fingerprinting lab
8. The microscope
9. Forensic hair analysis and DNA lab
10. Hand writing evaluation
11. Paper chromatography and thin-layer chromatography lab
12. Trajectories and impact lab: Ballistics
13. Blood: Pattern and stain analysis lab
14. Coefficient of friction lab
15. Conservation of energy and momentum: Collisions lab
16. Tool mark analysis
17. Footwear impressions lab: Stress and strain
18. Forensic entomology activity
19. Forensic anthropology activity
20. The t-shirt mystery lab

Assessment

Student proficiency (satisfactory achievement) in each of the outcomes/objectives listed in this guide shall be determined by student attainment of the 70% district passing standard, which pertains to all curricula and populations. Such proficiency shall be measured by a multiplicity of evaluation techniques and instruments, which includes, but is not restricted to the following:

1) Teacher-made tests at the end of each chapter. Test average accounts for 30% of the marking period grade.

2) Laboratory activities, written reports and projects. These alternative assessments account for 25% of the marking period grade.

3) Teacher-made quizzes and/or oral presentations. Quizzes will be given periodically to assess student comprehension. Oral presentations will be assigned as research projects or criminal case investigations. These assessments account for 25% of the marking period grade.

4) Homework assignments. The average of these assignments account for 20% of the marking period grade.

5) Final assessment test or project as required by the district at the end of the year. This assessment accounts for one ninth of the final grade.

Instructional Resources

Required Text:

1. **Textbook: Forensic Science: An Introduction (2008)**
   by Richard Saferstein;
   Pearson, Prentice Hall
   ISBN-13:978-13-196142-5
   ISBN-10: 0-13-196142-x

2. **Basic Laboratory Exercises for Forensic Science**
   by Richard Saferstein;
   Pearson, Prentice Hall
   ISBN: 0-13-196143-8

3. **Teacher Resources and Additional Publications**
   Supplemental Resources:

4. **Internet**

5. **Dvd's and Videos**

6. **Newspaper Articles**

7. **Guest Speakers**

8. **Field Trips**