



# Pine Grove Area

SCHOOL DISTRICT

Science

Physics

February 19, 2009

## I. PHILOSOPHY

**Physics is the application of mathematics to the physical world. This main thrust of this course is to introduce students to the physical properties of matter and energy and how they are related. A solid background in mathematics is essential in successful completion of this course.**

## **II. CORE CONCEPTS**

1. Linear motion- Use Newton's equations relating displacement, velocity, acceleration, and time.
2. Vector algebra- Understand how to use vectors to describe various quantities and how to combine the vectors.
3. Graphing physical quantities- Understand how to construct various graphs on quadrille paper and using a graphing calculator
4. Forces in one dimension- Understand how the forces are related and use appropriate formulas in determining forces.
5. Forces and motion in two dimensions- Understand how to combine two or more forces in two dimensions.
6. Universal gravitation and the cosmology- Understand Newton's Law of Universal Gravitation and the cosmology.
7. Momentum and its conservation- Understand momentum and its conservation in all situations and how it applies to collisions.
8. Work, energy, and simple machines- Understand the relationship between work and energy and how it applies to simple machines.
9. States of matter- Understand how the various states of matter are related and how various principles apply to matter and its motion.
10. Waves and energy transfer- Understand how all properties of waves apply to all waves regardless of types or medium.

### **III. COURSE OF STUDY**

- A. Course Name: Physics
- B. Grade Level: 11 and 12
- C. Length of Course: full year
  - 1. Frequency: one period daily
  - 2. Duration: 42 minutes
- D. Academic Level: College Preparatory
- E. Credits: 1.12
- F. Prerequisites: Algebra I and II, Geometry, and Trigonometry is strongly recommended
- G. Course Description:

Physics is the study of matter and energy. Since mathematics is the language of physics, students will be expected to apply previously learned mathematics in practical situations. Discussions of physical principles and concepts will be introduced in lectures, demonstrations, and laboratory experiments. Physics is required of all students who will be majoring in STEM (Science, Technology, Engineering, and Mathematics) in college and highly recommended for those with an inquisitive mind about the world around us. It will include discussions from the tiniest of subatomic particles to the vast reaches of the universe and everything in between.

**IV. CONTENT: CP Physics**

**CORE CONCEPT 1: Linear motion**

**MAJOR OBJECTIVE: Use Newton's equations relating displacement, velocity, acceleration, and time.**

<b>CURRICULUM STANDARD:</b>			
PA State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
3.1.12D Analyze scale as a way of relating concepts  <ul style="list-style-type: none"><li>• Compare and contrast various forms of dimension analysis.</li><li>• Assess the use of several units of measurement to the same problem.</li><li>• Analyze and apply appropriate measurement scales in data collection.</li></ul>	Teacher will guide students to:  <ul style="list-style-type: none"><li>• Calculate displacement, velocity, acceleration, and time in multiple ways</li><li>• Apply appropriate units</li><li>• Construct graphs and interpret information.</li><li>• Demonstrate various types of linear motion using constant velocity machines.</li><li>• Derive motion formulas from the definitions of velocity and displacement.</li></ul>	Teacher evaluation of:  <ul style="list-style-type: none"><li>• White board work.</li><li>• Class discussion.</li><li>• Laboratory reports/notebooks.</li><li>• Tests/quizzes.</li></ul>	Computer programs/web sites  Journals or notebooks Supplemental materials Graphing calculators Textbook resources

**CONTENT: CP Physics**

**CORE CONCEPT 1: Linear motion**

**MAJOR OBJECTIVE: Use Newton’s equations relating displacement, velocity, acceleration, and time.**

**CURRICULUM STANDARD:**

PA State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.4.12.C Apply the principles of motion and force.</p> <ul style="list-style-type: none"><li>Analyze the principles of motion, velocity, and acceleration.</li><li>Interpret a model that illustrates acceleration.</li><li>Describe inertia, motion, and equilibrium.</li></ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"><li>Evaluate experimental data within experimental limits.</li><li>Judge that conclusions are consistent with experimental conditions.</li><li>Interpret results of an experiment..</li></ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"><li>Calculate displacement, velocity, acceleration, and time in multiple ways</li><li>Apply appropriate units</li><li>Construct graphs and interpret information.</li><li>Demonstrate various types of linear motion using constant velocity machines.</li><li>Derive motion formulas from the definitions of velocity and displacement.</li></ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"><li>White board work.</li><li>Class discussion.</li><li>Laboratory reports/notebooks.</li><li>Tests/quizzes.</li></ul>	<p>Computer programs/web sites</p> <p>Journals or notebooks</p> <p>Supplemental materials</p> <p>Graphing calculators</p> <p>Textbook resources</p>

**CONTENT: CP Physics**

**CORE CONCEPT 2: Vector algebra**

**MAJOR OBJECTIVE: Understand how to use vectors to describe various quantities and how to combine the vectors.**

**CURRICULUM STANDARD:**

State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.1.12.A Apply concepts to solve complex problems.</p> <ul style="list-style-type: none"><li>Analyze and describe functions</li><li>Compare and contrast several systems that could be applied to a problem.</li><li>Evaluate the causes of a system's inefficiency.</li></ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"><li>Evaluate experimental data within experimental limits.</li><li>Judge that conclusions are consistent with experimental conditions.</li><li>Interpret results of an experiment.</li></ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"><li>Add two or more vectors using vector algebra</li><li>Determine perpendicular components of vectors.</li><li>Add two or more vectors using the summation method.</li><li>Show how subtraction of vector could be accomplished by adding the opposite.</li><li>Describe various quantities as scalar or vector.</li><li>Discuss the various ways of describing direction for vectors.</li><li>Discuss various types of coordinate systems that can be used in graphing.</li></ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"><li>White board work.</li><li>Class discussion.</li><li>Laboratory reports/notebooks.</li><li>Tests/quizzes.</li></ul>	<p>Computer programs/web sites</p> <p>Journals or notebooks</p> <p>Supplemental materials</p> <p>Graphing calculators</p> <p>Textbook resources</p>

**CONTENT: CP Physics**

**CORE CONCEPT 3: Graphing physical quantities**

**MAJOR OBJECTIVE: Understand how to construct various graphs on quadrille paper and using a graphing calculator**

**CURRICULUM STANDARD:**

State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.1.12.B Apply concepts of models as a method to predict outcomes.</p> <ul style="list-style-type: none"> <li>• Evaluate processes by collecting data and applying math models.</li> <li>• Apply knowledge of complex physical models to interpret data.</li> <li>• Appraise the importance of computer models in interpreting data.</li> </ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"> <li>• Evaluate experimental data within experimental limits.</li> <li>• Judge that conclusions are consistent with experimental conditions.</li> <li>• Interpret results of an experiment.</li> </ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"> <li>• Collect data and arrange on paper and input to the Stat mode of a graphing calculator.</li> <li>• Discuss various types of coordinate systems that can be used in graphing.</li> <li>• Prepare a graph with appropriate units.</li> <li>• Analyze the data presented on the graph.</li> <li>• Assess the data to arrive at a conclusion</li> <li>• Describe the curve that denotes a direct, inverse, and quadratic relationship.</li> <li>• Do various motion labs and explain the use of a spark timer.</li> </ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"> <li>• White board work.</li> <li>• Class discussion.</li> <li>• Laboratory reports/notebooks.</li> <li>• Tests/quizzes.</li> </ul>	<p>Textbook resources</p> <p>Computer programs/web sites</p> <p>Journal or notebook</p> <p>Supplemental materials</p> <p>Graphing calculators</p>

**CONTENT: CP Physics**

**CORE CONCEPT 4: Forces in one dimension**

**MAJOR OBJECTIVE: Understand how the forces are related and use appropriate formulas in determining forces.**

**CURRICULUM STANDARD:**

State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.4.12.A Apply concepts about the structure and properties of matter.</p> <ul style="list-style-type: none"><li>• Explain how forces affect properties of matter.</li></ul> <p>3.4.12.C Apply the principles of motion.</p> <ul style="list-style-type: none"><li>• Analyze the principles of motion.</li></ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"><li>• Evaluate experimental data within experimental limits.</li><li>• Judge that conclusions are consistent with experimental conditions.</li><li>• Interpret results of an experiment.</li></ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"><li>• Solve force problems graphically and mathematically.</li><li>• Construct vector diagrams using scale drawings.</li><li>• Find appropriate units.</li><li>• Do a dimensional analysis.</li><li>• Display addition of vectors on a number line and show how vector algebra is appropriate in one and two dimensions.</li></ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"><li>• White board work.</li><li>• Class discussion.</li><li>• Laboratory reports/notebooks.</li><li>• Tests/quizzes.</li></ul>	<p>Textbook resources</p> <p>Computer programs/web sites</p> <p>Journal or notebook</p> <p>Supplemental materials</p> <p>Graphing calculators</p>

**CONTENT: CP Physics**

**CORE CONCEPT 5: Forces in two dimensions**

**MAJOR OBJECTIVE: Understand how to combine two or more forces in two dimensions.**

**CURRICULUM STANDARD:**

State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.4.12.A Apply concepts about the structure and properties of matter.</p> <ul style="list-style-type: none"><li>• Explain how forces affect properties of matter.</li></ul> <p>3.4.12.C Apply the principles of motion.</p> <ul style="list-style-type: none"><li>• Analyze the principles of translational motion.</li><li>• Describe inertia, motion, and equilibrium.</li><li>• Analyze the principles of motion.</li></ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"><li>• Evaluate experimental data within experimental limits.</li><li>• Judge that conclusions are consistent with experimental conditions.</li><li>• Interpret results of an experiment.</li></ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"><li>• Solve force problems graphically and mathematically.</li><li>• Construct vector diagrams using scale drawings.</li><li>• Find appropriate units and do a dimensional analysis.</li><li>• Perform force board labs.</li><li>• Demonstrate the addition of vectors with actual physical arrows and show how vector algebra is appropriate in all situations.</li></ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"><li>• White board work.</li><li>• Class discussion.</li><li>• Laboratory reports/notebooks.</li><li>• Tests/quizzes.</li></ul>	<p>Textbook resources</p> <p>Computer programs/web sites</p> <p>Journal or notebook</p> <p>Supplemental materials</p> <p>Graphing calculators</p>

**CONTENT: CP Physics**

**CORE CONCEPT 6: Universal gravitation and the cosmology**

**MAJOR OBJECTIVE: Understand Newton's Law of Universal Gravitation and the cosmology.**

**CURRICULUM STANDARD:**

State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.1.12.E. Evaluate change in nature, physical systems, and man made systems as related to Copernican and Ptolemaic universe theories.</p> <ul style="list-style-type: none"><li>• Compare and contrast the two systems.</li></ul> <p>3.4.12.D Analyze the essential ideas about the composition and structure of the universe.</p> <ul style="list-style-type: none"><li>• Analyze the Big Bang Theory and other possible explanations of the the origins of the universe.</li><li>• Correlate the use of special relativity and life of a star.</li></ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"><li>• Evaluate experimental data within experimental limits.</li><li>• Judge that conclusions are consistent with experimental conditions.</li><li>• Interpret results of an experiment.</li></ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"><li>• Solve universal gravitational problems.</li><li>• Discuss Newton's classical view of gravity</li><li>• Discuss Einstein's view of the space-time continuum and his theory of relativity.</li><li>• Discuss the recent demotion on Pluto as a planet.</li><li>• Examine the map of our solar system and how Kepler's Laws apply to all planets.</li><li>• Compare the revolution of planets with that of the electrons.</li><li>• Discuss various quantities in the universe like black holes, quasars, pulsars, etc.</li></ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"><li>• White board work.</li><li>• Class discussion.</li><li>• Laboratory reports/notebooks.</li><li>• Tests/quizzes.</li></ul>	<p>Textbook resources</p> <p>Computer programs/web sites</p> <p>Journal or notebook</p> <p>Supplemental materials</p> <p>Graphing calculators</p>

**CONTENT: CP Physics**

**CORE CONCEPT 7: Momentum and its conservation.**

**MAJOR OBJECTIVE: Understand momentum and its conservation in all situations and how it applies to collisions.**

<b>CURRICULUM STANDARD:</b>			
State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.4.12.A. Apply concepts about the structure and properties of matter</p> <ul style="list-style-type: none"> <li>Apply the conservation of energy concepts to other properties.</li> <li>Quantify the properties of matter.</li> </ul> <p>3.4.12.C. Apply the principles of motion and force.</p> <ul style="list-style-type: none"> <li>Analyze the principles of motion.</li> </ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"> <li>Evaluate experimental data within experimental limits.</li> <li>Judge that conclusions are consistent with experimental conditions.</li> <li>Interpret results of an experiment.</li> </ul> <p>3.4.12.A. Apply the concepts about the structure and properties of matter.</p> <ul style="list-style-type: none"> <li>Apply the conservation of energy concept to diverse fields.</li> </ul> <p>3.4.12.C. Apply the principles of motion and force.</p> <ul style="list-style-type: none"> <li>Analyze the principles of motion.</li> </ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"> <li>Solve momentum problems.</li> <li>Describe the motion involved in various collisions.</li> <li>Do a dimensional analysis of the units.</li> <li>Design and implement collision labs in one and two dimensions.</li> <li>Discuss how energy dissipates as heat and sound but momentum is conserved.</li> </ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"> <li>White board work.</li> <li>Class discussion.</li> <li>Laboratory reports/notebooks.</li> <li>Tests/quizzes.</li> </ul>	<p>Textbook resources</p> <p>Computer programs/web sites</p> <p>Journal or notebook</p> <p>Supplemental materials</p>

**CONTENT: CP Physics**

**CORE CONCEPT 8: Work, energy, and simple machines**

**MAJOR OBJECTIVE: Understand the relationship between work and energy and how it applies to simple machines.**

<b>CURRICULUM STANDARD:</b>			
State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.4.12.C. Apply the principles of motion.</p> <ul style="list-style-type: none"> <li>Analyze the principles of motion.</li> <li>Analyze the principles of rotational motion.</li> <li>Describe inertia, motion, and equilibrium.</li> </ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"> <li>Evaluate experimental data within experimental limits.</li> <li>Judge that conclusions are consistent with experimental conditions.</li> <li>Interpret results of an experiment.</li> </ul> <p>3.4.12.A. Apply the concepts about the structure and properties of matter.</p> <ul style="list-style-type: none"> <li>Apply the conservation of energy concept to diverse fields.</li> </ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"> <li>Solve work, energy, and mechanical advantage problems</li> <li>Demonstrate the mechanical advantage of levers and pulleys.</li> <li>Discuss the importance of mechanical advantage.</li> <li>Compare real and ideal machines.</li> <li>Discuss complex machines.</li> <li>Analyze the various bridge constructions and how they are related to levers.</li> </ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"> <li>White board work.</li> <li>Class discussion.</li> <li>Laboratory reports/notebooks.</li> <li>Tests/quizzes.</li> </ul>	<p>Textbook resources</p> <p>Computer programs/web sites</p> <p>Journal or notebook</p> <p>Supplemental materials</p>

CONTENT: CP Physics

CORE CONCEPT 9: States of matter

MAJOR OBJECTIVE: Understand how the various states of matter are related and how various principles apply to matter and its motion.

CURRICULUM STANDARD:			
State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.2.12.A. Evaluate the nature of scientific and technological knowledge.</p> <ul style="list-style-type: none"> <li>Critical evaluation of the status of existing theories.</li> </ul> <p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"> <li>Evaluate experimental data within experimental limits.</li> <li>Judge that conclusions are consistent with experimental conditions.</li> <li>Interpret results of an experiment.</li> </ul> <p>3.4.12.A. Apply the concepts about the structure and properties of matter.</p> <ul style="list-style-type: none"> <li>Quantify the properties of matter (ie. Density.)</li> </ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"> <li>Discuss the properties of solids, liquids, gasses, and plasma.</li> <li>Perform the lab to determine the density of various objects.</li> <li>Discuss how volume displacement of a liquid can be used to determine volume.</li> <li>Derive the formula for Archimedes' principle and how it applies to a displaced fluid.</li> <li>Discuss Pascal's Principle and how it affects us.</li> <li>Discuss Bernoulli's Principle and how it is related to the motion of an airplane and the flight of a baseball.</li> </ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"> <li>White board work.</li> <li>Class discussion.</li> <li>Laboratory reports/notebooks.</li> <li>Tests/quizzes.</li> </ul>	<p>Textbook resources</p> <p>Computer programs/web sites</p> <p>Journal or notebook</p> <p>Supplemental materials</p>

**CONTENT: CP Physics**

**CORE CONCEPT 10: Waves**

**MAJOR OBJECTIVE: Understand how all properties of waves apply to all waves regardless of types or medium.**

**CURRICULUM STANDARD:**

State Standard/Student Expectation	Specific Content	Assessments	Resources/Materials
<p>3.2.12.B. Evaluate experimental information.</p> <ul style="list-style-type: none"><li>• Evaluate experimental data within experimental limits.</li><li>• Judge that conclusions are consistent with experimental conditions.</li><li>• Interpret results of an experiment.</li></ul> <p>3.4.12.C. Apply the principles of motion and force.</p> <ul style="list-style-type: none"><li>• Evaluate wave properties of frequency, wavelength, and speed.</li></ul>	<p>Teacher will guide students to:</p> <ul style="list-style-type: none"><li>• Discuss various types of waves and how they are generated.</li><li>• Demonstrate various types of waves using various media.</li><li>• Solve problems involving speed, frequency, wavelength and period of waves.</li><li>• Describe properties of waves.</li><li>• Explain and display reflection, refraction, and diffusion.</li><li>• Discuss the electromagnetic spectrum.</li><li>• Demonstrate the effect of a change in medium on the speed, frequency, and period of a wave.</li></ul>	<p>Teacher evaluation of:</p> <ul style="list-style-type: none"><li>• White board work.</li><li>• Class discussion.</li><li>• Laboratory reports/notebooks.</li><li>• Tests/quizzes.</li></ul>	<p>Textbook resources</p> <p>Computer programs/web sites</p> <p>Journal or notebook</p> <p>Supplemental materials</p>

## V. EXPECTED LEVELS OF ACHIEVEMENT

A. Students are expected to reach the proficient level (C or above) of achievement, including all of the skills noted in the specific content area of this curriculum.

B. Grading system C.P. Physics is as follows:

<b>Grading Scale</b>	
A	90-100
B	80-89
C	70-79
D	60-69
F	0-59

C. Each student's grade will be determined at the conclusion of each marking period. Progress notes will be issued half-way throughout each marking period to students who are performing below 70%.

## VI. PHYSICS SUGGESTED COURSE OUTLINE

The purpose of this course is to give students a working knowledge of various physical properties of matter and energy. It is recommended that students take trigonometry before this class, but it is not required. In any case, the course includes a lesson on the trig functions of sine, cosine, and tangent for use in solving right triangles. Most of the triangles throughout the course will be right or will be reduced to the perpendicular components which will then form right triangles.

- I. Chapter 1 Introduction to scientific method and reasons for studying physics
- II. Chapter 2 Metric System, scientific notation, significant notation, Graphing data, linear and inverse relationships
- III. Chapter 3 Linear motion- introduction to diagrams and graphs

- IV. Chapter 4 Vector Addition- solving vector algebra graphically and mathematically. Review trig functions and right triangles.
- V. Chapter 5 Linear motion using graphs, diagrams, and equations for displacement, velocity, acceleration, and time.
- VI. Chapter 6 Forces Newton's 3 Laws of Force and motion, periodic motion, and discussion of fundamental forces and the latest theories.
- VII. Chapter 7 Forces and Motion in Two Dimensions-vector algebra is used to solve inclined plane, projectile motion, and circular motion problems.
- VIII. Chapter 8 Universal Gravitation and cosmology- discussion of latest theories of the universe.
- IX. Chapter 9 Momentum and its conservation (skip two dimensional collisions, but include that in Advanced Physics.)
- X Chapter 10 Work, Energy, and Simple Machines ( skip the compound machines, but include those in Advanced Physics).
- XI. Chapter 11 Energy Kinetic and Potential Energy and conservation of energy.
- XII. Chapter 12 Thermal Energy- energy transfer, specific heat, calorimetry, 2 laws of thermodynamics.
- XIII. Chapter 13 States of Matter- Pascal's, Archimedes', and Bernoulli's Principles.
- XIV. Chapter 14 Waves and Energy Transfer- period, speed, frequency, and amplitude. Any of the following chapters are optional depending on time and students' interest.
- XV. Chapter 15 Sound
- XVI. Chapter 16 Light- discuss two ways to determine the speed of light.
- XVII. Chapter 17 Reflection and Refraction -Snell's Law, index of refraction, and the Speed of light.
- XVIII Chapter 18 Mirrors and Lenses- mirror diagrams done graphically to scale and solved mathematically. Do a few lens diagrams and problems.

## Physics Formula Sheet

$$d = d_0 + vt$$

$$F = ma + F_f$$

$$\sin \theta = \frac{\text{Opp}}{\text{Hyp}}$$

$$a_c = \frac{v^2}{r}$$

$$v = \sqrt{\frac{GM_0}{r}}$$

$$F_G = G \frac{m_1 m_2}{d^2}$$

$$F \Delta t = m \Delta v$$

$$W = Fd$$

$$KE = 1/2 mv^2$$

$$c_{\text{water}} = 4180 \text{ J / kg } ^\circ\text{C}$$

$$\text{J/kg } H_{\text{v(water)}} = 2.26 \times 10^6 \text{ J/kg}$$

$$Q = mH_f \quad Q = mH_v \quad p = \frac{F}{A} \quad F_{\text{buoy}} = \rho V g \quad \Delta L = L_i \alpha \Delta T \quad \Delta W = V_i \beta \Delta T$$

$$F_{\text{app}} = F_{\text{air}} - F_{\text{buoyant}}$$

$$d = d_0 + v_0 t + 1/2 at^2$$

$$F = ma + mg$$

$$\cos \theta = \frac{\text{Adj}}{\text{Hyp}}$$

$$F_c = \frac{mv^2}{r}$$

$$T = 2\pi \sqrt{\frac{r^3}{GM_0}}$$

$$p = mv$$

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$P = \frac{W}{t}$$

$$PE = mgh$$

$$Q = mc \Delta t$$

$$H_{f(\text{water})} = 3.34 \times 10^5$$

$$v_f = v_0 + at$$

$$\mu = \frac{F_f}{F_N}$$

$$\tan \theta = \frac{\text{Opp}}{\text{Adj}}$$

$$F_c = \frac{4m\pi^2 r}{T^2}$$

$$T = 2\pi \sqrt{\frac{l}{g}}$$

↑ ( $M_0$  is the mass of the object being orbited)

$$MA = \frac{F_r}{F_e}$$

$$Q_{\text{lost}} = Q_{\text{gained}}$$

$$\rho = m/V$$

$$IMA = \frac{d_e}{d_r}$$

$$\text{eff} = \frac{MA}{IMA}$$

$$\text{eff} = \frac{W_o}{W_i}$$

$$\rho_{\text{water}} = 1000 \text{ kg / m}^3 = 1 \text{ g / cc}$$

$$1\text{atm} = 1.01 \times 10^5 \text{Pa} = 760\text{mmHg}$$

$$v = \lambda f \quad f = \frac{1}{T} \quad E = \frac{P}{4\pi d^2} \quad n_i \sin \theta_i = n_r \sin \theta_r \quad n_s = \frac{c}{v_s} \quad \frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$m = \frac{h_i}{h_o} = \frac{-d_i}{d_o} \quad F_E = k \frac{q_1 q_2}{d^2} \quad E = \frac{F}{q} \quad V = Ed \quad C = \frac{q}{V} \quad R = \frac{V}{I} \quad P = VI$$

$$P = I^2 R \quad E = I^2 R t \quad R_{\text{series}} = R_1 + R_2 + R_3 \quad \frac{1}{R_{\text{para}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad E = mc^2$$

$$v = \lambda f \quad f = \frac{1}{T} \quad E = \frac{P}{4\pi d^2} \quad n_i \sin \theta_i = n_r \sin \theta_r \quad n_s = \frac{c}{v_s} \quad \frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$m = \frac{h_i}{h_o} = \frac{-d_i}{d_o} \quad F_E = k \frac{q_1 q_2}{d^2} \quad E = \frac{F}{q} \quad V = Ed \quad C = \frac{q}{V} \quad R = \frac{V}{I} \quad P = VI$$

## Physics Labs

1. Linear motion and use of the spark timers.
2. Uniform accelerated motion.
3. Measurement lab finding density using rulers, vernier calipers, graduated cylinders, scales.
4. Force and acceleration
5. Force board.
6. Projectile motion using a catapult
7. Centripetal force
8. Coefficient of friction on and inclined plane
9. Period of a pendulum
10. Centripetal force
11. Conservation of momentum
12. Specific heat of a metal
13. Heat of fusion of ice
14. Archimedes' Principle
15. Slinky demonstration
16. Ripple tank demonstration
17. Throwing a baseball
18. Lever
19. Pulley
20. Inertial mass
21. Horsepower
22. Snell's Law
23. Mirror and lens demonstration
24. Beakman's electric motor
25. Magnetic field demonstration
26. Building tower from one piece of paper