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Rapid Learning Center Presents …

Teach Yourself AP Physics 1 & 2 in 24 Hours

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Introduction to AP Physics 1 & 2

AP Physics Rapid Learning Series

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Learning Objectives

By viewing this tutorial, you will learn about:

- What AP Physics is.
- What the AP Exam is.
- The Re-designed Curriculum
- AP Physics 1 vs. 2
- AP Physics 1 Content Outline
- AP Physics 2 Content Outline
- How to Study AP Physics
- AP Test-Prep Strategies
- AP Exam-Taking Strategies

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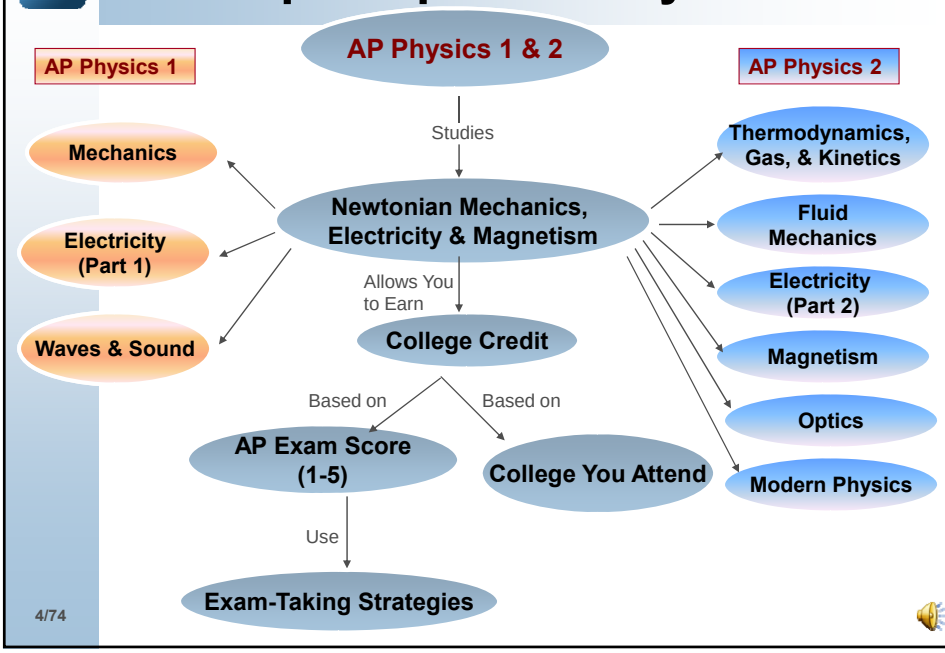
Concept Map – AP Physics



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What is AP Physics?

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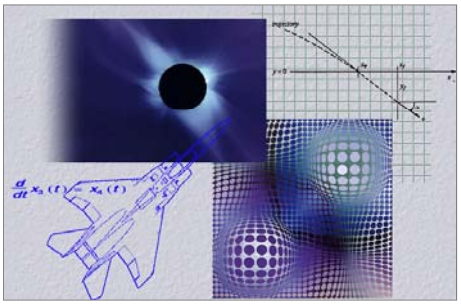
AP Physics - Defined

Advanced Placement (AP) Physics is a set of college general physics courses offered to US/Canadian high school students. An exam is taken at the end (in May) to obtain a college credit.



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AP Physics – Courses

There are four AP Physics courses and exams – two are taught as in a full-year curriculum and the other two in one-semester each. The exams are given in May of each year.

AP Physics 1
Algebra-based one year course in high school (equivalent to 1st semester general physics in college)

AP Physics 2
Algebra-based one year course in high school (equivalent to 2nd semester general physics in college)

AP Physics C: Mechanics
Calculus-based one semester course in high school (equivalent to one-semester introductory college course)

AP Physics C: Electricity and Magnetism
Calculus-based one semester course in high school (equivalent to one-semester introductory college course)

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What is the AP Exam?

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AP Physics Exam

AP Physics Exam – It is a cumulative exam given in May. Scores range from 1 to 5 (5 being the highest). Colleges decide how much credit is given for each score in each subject. Students with qualified scores could receive college credit and/or placement into more advanced courses in college.

More importantly, it helps students to be more competitive in college admission applications. An AP Physics credit can add into the strength of an applicant's academic program.

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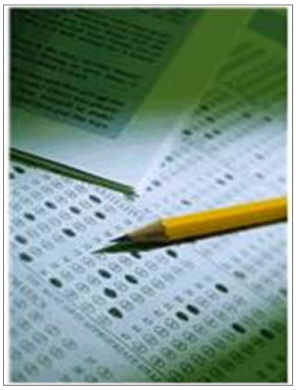
Scope of the Exam

When the exam is prepared, it is understood that, due to variations in teaching style, each student will not know everything on the subject. Therefore, the questions are written over each topic and, as such, the examiners do not expect any one student to know all the answers.



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Types of Questions

The AP Physics exam is made up of two types of questions: multiple choice and free response. **Multiple choice** questions test conceptual understanding and must be completed timely. There may be information contained in a paragraph, table or figure for each question and there are 4 possible answer choices.

The exam also includes free **response questions**, which are printed in a separate booklet. The free response questions may ask for a written response, interpretation of a result or to derive an expression based on the information presented.

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AP Physics 1 - Exam Format

AP Physics 1 exam covers the contents of the entire course. It consists of two equally weighted sections – multiple choice and free response, each 90 minutes. This exam is 3 hours long.

Section I: Multiple Choice	Section II: Free Response
50% of the exam grade	50% of the exam grade
90 minutes	90 minutes
50 questions: ▪ 45 Single-select (one correct answer) ▪ 5 Multi-select (two correct answers)	5 questions: • 1 Experimental design • 1 Quantitative/Qualitative translation • 3 Short answers

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AP Physics 2 - Exam Format

AP Physics 2 exam covers topics of this course. It also consists of two sections – multiple choice and free response, each 50% of the exam score and each 90 minutes in length. This exam is 3 hours long. The format is almost identical to Physics 1, except one less free response question.

Section I: Multiple Choice	Section II: Free Response
50% of the exam grade	50% of the exam grade
90 minutes	90 minutes
50 questions: ▪ 45 Single-select (one correct answer) ▪ 5 Multi-select (two correct answers)	4 questions: • 1 Experimental design • 1 Quantitative/Qualitative translation • 2 Short answers

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AP Physics Exam - Calculator

Calculator Policy:

•Calculator is allowed for both multiple choice and free response sections in AP Physics 1 & 2.

•Scientific or graphing calculator is allowed.

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The Equation Tables and Constants

The AP exams provide an equation table and constants for both the multiple-choice and free-response sections.

AP Physics 1 – Table of Information & Equation Sheet.

AP Physics 2 - Table of Information & Equation Sheet.

Become familiar with this document and use it throughout your course so that you'll be able to quickly find information on it in May!

The actual equation table might be varied from year to year. Check the AP exam guide for the latest version at CollegeBoard.org website.

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AP Redesigned Curriculum - 7 Big Ideas

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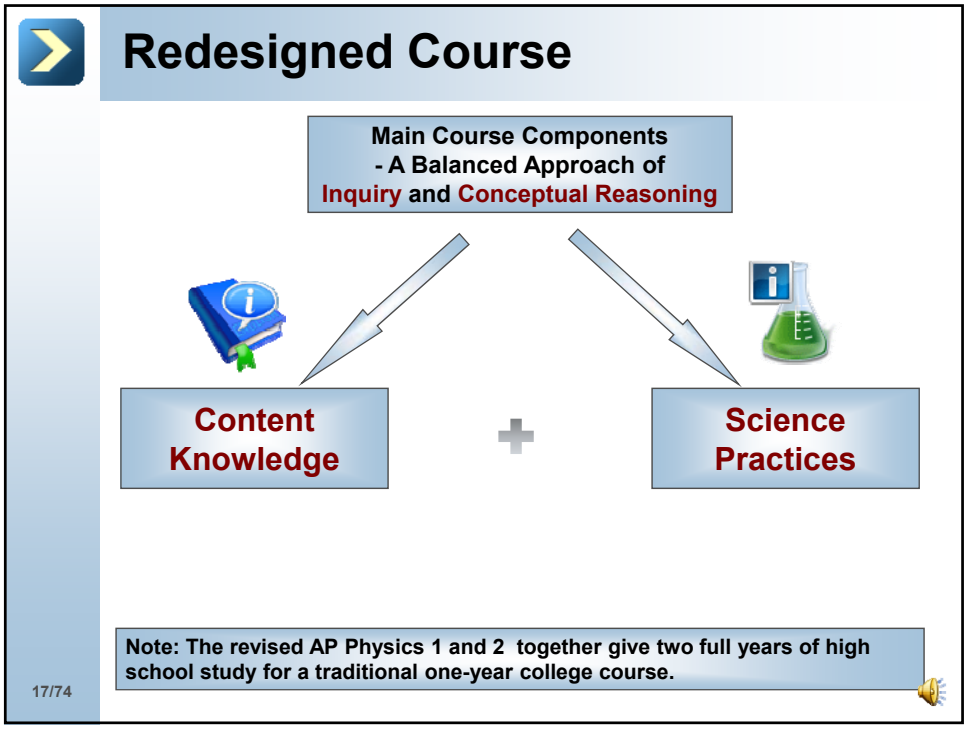
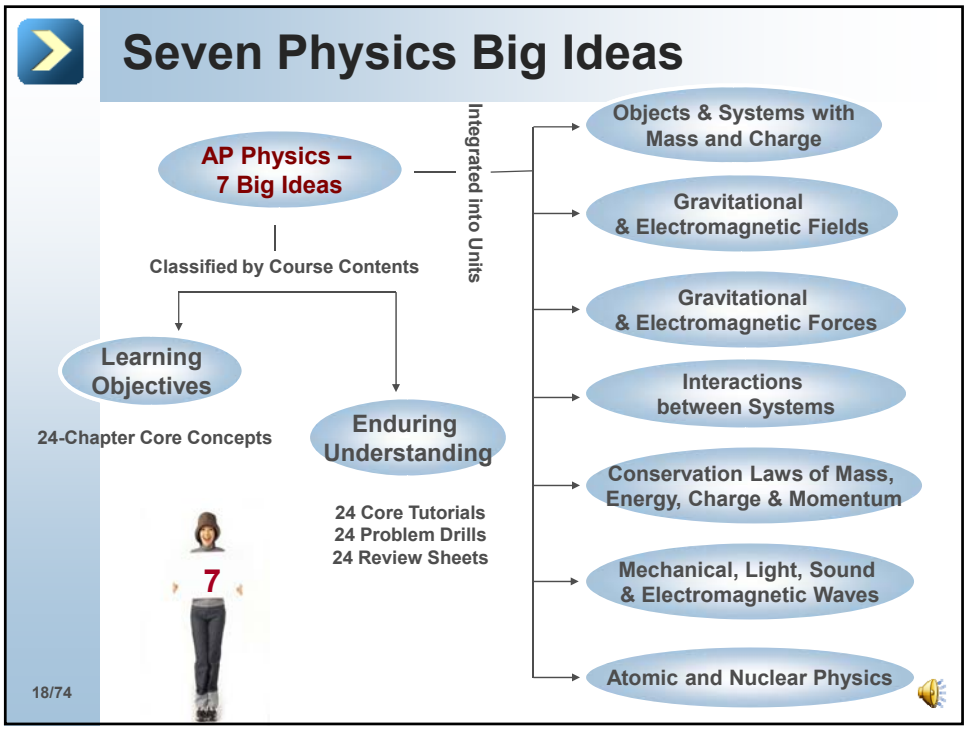
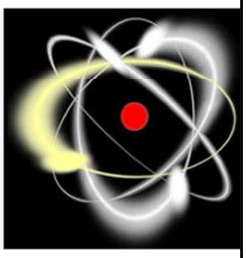




AP Physics 1 vs AP Physics 2



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Course Objectives: AP Physics 1&2

Rapid Learning offers Physics 1&2 as a combo course and Physics C Mechanics and E&M also as 2-in-1 course. Physics 1 is the 1st semester of general physics and Physics 2 is the 2nd semester of general physics at the college level. It takes two years of AP Physics in high school to cover one year of content in college.

The AP physics 1&2 is geared towards people majoring in the life sciences - students who wish to pursue an education in the life sciences, medicine or geology.

The AP physics C is geared towards people majoring in physical sciences or engineering. Along with earning credit towards this path of education, students would also benefit from the AP Calculus course.

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Topics of AP Physics 1&2

The Physics 1 covers the following topics: classical mechanics, electricity part 1, waves and sound. It is an introductory algebra-based course with no prior physics requirement. Algebra with triginometry is the math pre-requisite for this course.

The Physics 2 covers the following topics:Thermodynamics, ideal gases, kinetics, electricity part 2, magnetism, fluid mechanics, optics, atomic and nuclear physics. One must complete Physics 1 before taking the 2.

There are fewer topics covered in both Physics 1 and 2, such as electricity. In general, these two courses have little overlap and should be taken in 1-2 sequence.

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Math Requirements for AP Physics 1&2

The AP Physics 1&2 exams will draw on your mathematical skills as a tool to solve the physics questions, not as a test of your math abilities. The mathematics required to be successful on the algebra-based AP Physics include: Algebra – including solving for unknown variables. Knowledge of equation basics, proportion basics, and combining similar terms and exponents of variables will be helpful to your success on this exam.

A general knowledge of Geometry is required for this test. This includes angles, perpendicular lines, distance, area and volume formulas.

Trigonometry knowledge is also required to solve problems that involve trigonometric functions.

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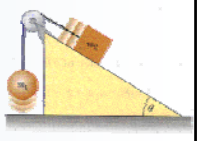
AP Physics 1 - Content Outline



This section is an overview of the topics with more in-depth study later in each specific tutorial.

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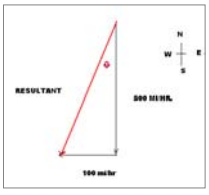
Kinematics

Kinematics – the branch of classical mechanics that includes a mathematical description of motion without any reference to the cause. The following are key aspects of Kinematics and object motion:

A **vector** is a quantity that has magnitude, size and direction. An example would be velocity or acceleration.

Motion in one direction: is described in terms of displacement, time, velocity, and acceleration.



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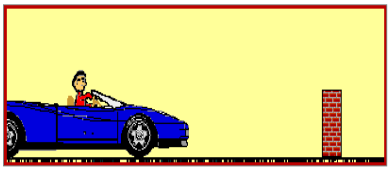
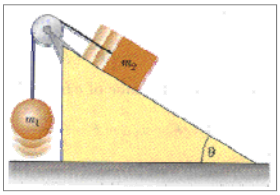
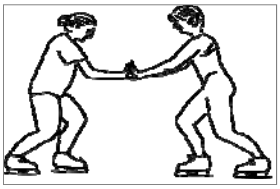
Newton's Laws

Newton's First Law: Every object continues in a state of rest, or uniform motion in a straight line, unless it is acted upon by an outside force (inertia).





Newton's Second Law: The acceleration of an object is directly proportional to the net force and inversely proportional to the mass.



Newton's Third Law: For every force, there is an equal and opposite force.

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Work, Energy and Power

Work – the amount of energy transferred by a force through a distance.

Kinetic Energy – the extra energy an object possesses because of its motion, measured in Joules.

$E_k = \frac{1}{2} mv^2$ where: E_k is the kinetic energy
m is the mass of the body
and *v* is the speed of the object

Power – the rate at which work is performed, for a given time.

$P = W / t$

W = work
t = time

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Question: Challenge

What are Newton's Laws?

Isaac Newton developed 3 laws: Newton's First Law: Every object continues in a state of rest, or uniform motion in a straight line, unless it is acted upon by an outside force (inertia), Newton's Second Law: The acceleration of an object is directly proportional to the net force and inversely proportional to the mass, and Newton's Third Law: For every force, there is an equal and opposite force.

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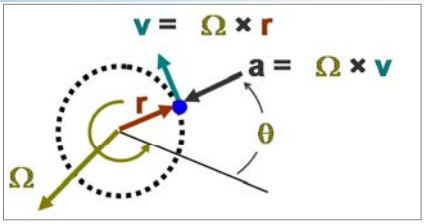
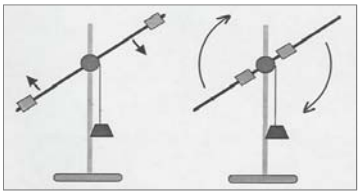
Circular Motion and Rotation



Circular Motion: rotation around a circular path or orbit. It can be uniform or non-uniform with a change in the rate of rotation.

Torque: or *tau*, the rate of change of an object's angular momentum is equal to the torque acting on it.



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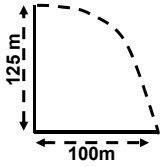
Multiple Choice Question: Kinematics

A car falls off a cliff 125 m high. It lands 100 m from the bottom of the cliff. How fast was the car going as it rolled off the cliff?

A. 10 m/s
B. 20 m/s
C. 25 m/s
D. 50 m/s



The initial speed of the car is calculated by using the equation describing the horizontal motion of the car:
$x = v_{ox}t$, $v_{ox} = 100/t$, where t = time.
$y = 125 - \frac{1}{2}gt^2$ ….. (1)
The ground is $y = 0$. Solve for t in equation (1). $t = 5$ s
$v_{ox} = 100/5 = 20$ m/s.

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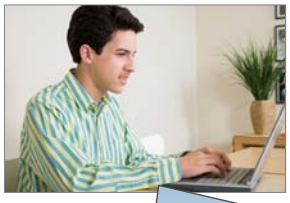
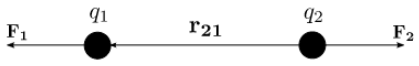
Electrostatics: Charge and Force

Electrostatics is the study of stationary, or slowly moving, electric charges.
When two objects in each other's vicinity have different electrical charges, an electrostatic force exists between them.





$F_1 = -F_2 = |F_E|$

Coulomb's Law is a mathematical description of the electric force between charged objects (q_1 & q_2) with a separation (r or r_{21}):

$$F_E = kq_1q_2/r^2$$

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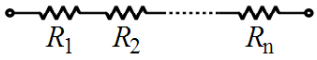
DC Circuit - Resistance

In DC circuits, the electrons flow with some opposition or resistance.

Resistance is measured in units called Ohms. The symbol is the Greek letter omega: Ω

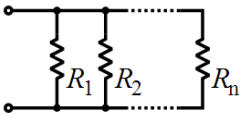
Resistors on a DC circuit board

There are two types of DC circuits – ***series*** and ***parallel***.



Series **Resistors**

$1/R_{eq} = (1/R_1) + (1/R_2) \ldots + (1/R_n)$



Parallel **Resistors**

$R_{eq} = (R_1) + (R_2) \ldots + (R_n)$

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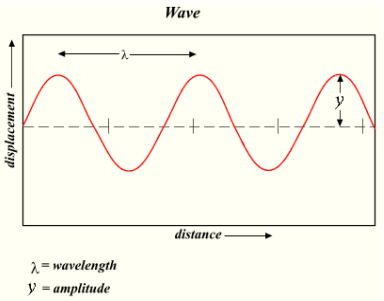
Waves and Sound

A wave is a periodic disturbance through which the sound or water wave travels. Waves can lead to reflection, refraction, interference and dispersion. Examples of waves include: sound waves, radio waves, ocean surface waves, and seismic waves in earthquakes.



Wave propagation is the way or directions the wave travels. A standing wave occurs when there is reflection and interference. The wave remains in constant position because the medium is moving in the opposite direction as the wave.

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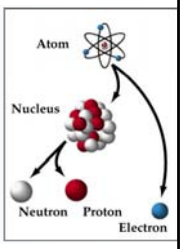
AP Physics 2 - Content Outline



This section is an overview the topics with more in-depth study later in each specific tutorial.

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Thermodynamics

Thermodynamics – The study of heat and temperature and their relationship to energy and work.

Heat – The flow of energy from higher temperature particles to lower temperature particles.

Calorimetry – Uses the energy change measured in the surroundings to find energy change of the system.

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Fluid Mechanics

Fluid mechanics is the study of how fluids (including liquids and gases) move and forces that act on them. The study of fluid motion can be divided into fluids at rest or static and dynamic motion.

Buoyancy is the upward force that keeps objects afloat, the net upward force is equal to the weight of water (fluid) displaced by the object.

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Question: Challenge

Define Buoyancy.

Buoyancy is the upward force that keeps objects afloat, the net upward force is equal to the weight of water (fluid) displaced by the object.

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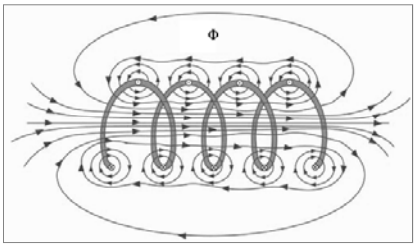
Electromagnetism

Electromagnetism is the study of an electromagnetic field, which exerts a force on particles – electric charge.

Magnetic flux (quantity of magnetism) = $\Phi_B = BA\cos\theta$

There are a number of terms and laws associated with electromagnetism, including:
(1) Permittivity.
(2) Faraday's Law.
(3) Tesla.
(4) Volt.
(5) Farad.



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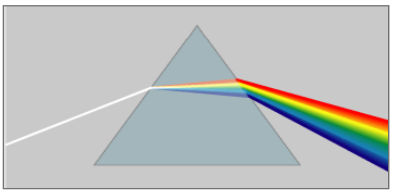
Geometric and Physical Optics

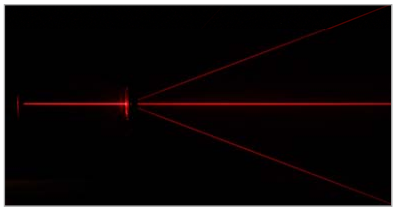
Optics - The study of the behaviour and properties of light, usually visible, ultravoilet and infrared light.

Geometric Optics – Deals with how light moves and where it goes such as reflection and refraction (by prism, lens, mirror).



Geometric - Refraction of Light

Physical Optics – Deals with the nature of light itself such as diffraction, interference and polarization (via grating etc.).



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Question: Challenge

What is the electromagnetic spectrum?

The electromagnetic spectrum is the range of all possible frequencies of electromagnetic radiation, from a wavelength of 0.1 Å to 1000 m. Within this spectrum is the visible light range from approximately 380 nm to 720 nm.

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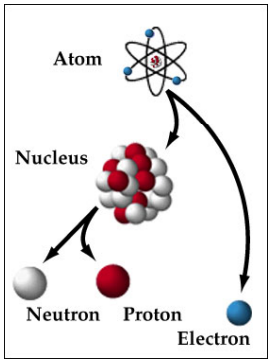
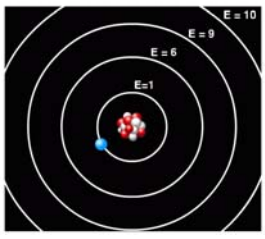
Atomic Physics

The study of atoms in isolated systems and the atomic nucleus is known as Atomic Physics.

The photoelectric effect was discovered by Heinrich Hertz and later explained by Albert Einstein. The photoelectric effect is the emission of electrons from matter (either metal or non-metal) in response to the absorption of electromagnetic radiation, such as light.





Within multi-electron atoms, such as helium, there can be different energy levels for its electrons and these can be described with an atomic energy level diagram. Electrons can be in a ground state or, under the right conditions, an excited state.

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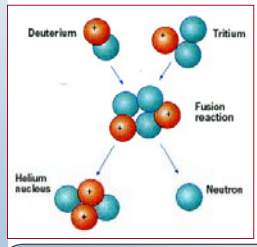
Nuclear Physics

The study of the interactions of atomic nuclei is the subject of **nuclear physics**. Early studies, including those with radium, and the discovery of the neutron are the early steps of the field of nuclear physics. When two nuclei or nuclear particles collide, a nuclear reaction can take place. In a nuclear reaction, the total energy is conserved and the types of reactions include Fusion reactions, which can lead to a thermonuclear explosion, and Fission reactions.



Mass-energy equivalence can be described with Einstein's equation: $E = mc^2$. The equation states that energy equals mass times the speed of light squared. Due to the fact that the speed of light is a massive number, even a small amount of matter contains a very large amount of energy.

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Question: Challenge

What is the photoelectric effect?

The **photoelectric effect** was discovered by Heinrich Hertz and later explained by Albert Einstein. The photoelectric effect is the emission of electrons from matter (either metal or non-metal) in response to the absorption of electromagnetic radiation, such as light.

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How to Study AP Physics

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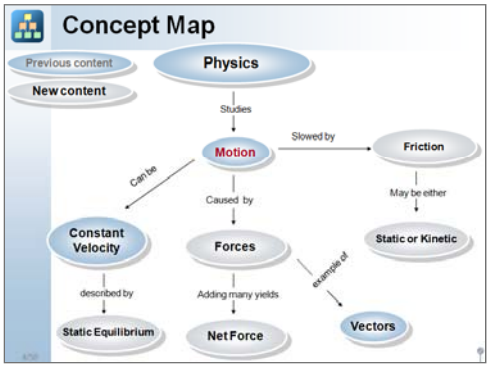
Connect Topics Together

As part of studying, connect new topics to things you already know.

Use a concept map to connect the ideas and information. Then, apply such an understanding to problem-solving.



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Effective Techniques

If you have trouble understanding the material, ask questions, either in class, before or after class, and during office hours. Don't let these burning questions go unanswered and pile up.

Partner with someone who is taking the same test and study together or form a study group to help and motivate one another.

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Focus on the Concepts and Connections

Everything may not make sense all at once. Focusing on the concepts and how the these concepts fit into the big picture will help you succeed in AP Physics.

In physics, often the question will be based on the actual concept, as opposed to the overall action.

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What is Problem-Solving?

You are here

Problem Solving Strategy

You need to get there

A "problem" is when you don't know how to get from here…

To there…

Problem-solving is needed in every aspect of physics: Labs & investigations, practice problems, exams, and any time you apply concepts to different situations.

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Example Problem

An 800 kg roller coaster is moving at a speed of 15 m/s. Determine the kinetic energy.

Remember kinetic energy is the energy of motion. If an object has motion, it has kinetic energy. Choose the correct formula that will provide the information being asked.

To calculate the kinetic energy, use:

$E_k = \frac{1}{2}mv^2$

$E_k = 0.5 \times 800kg \times (15\ m/s)^2$

$E_k = 90000$ Joules

1 Joule = 1 kg•m^2/s^2

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Practice - Practice - Practice

Practice physics problems to enhance what you learn and the connections. Do the full-length practice tests to familiarize yourself with the AP format. Be persistent until you get it.

Resist the temptation to look at the solution guide or to "Google" the answers.

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AP Test Preparation Strategies

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Four-Step Review Process

Follow this four-step process to successfully study and prepare for AP Physics exams with the Rapid Learning System (Core Tutorial – Problem Drill – Cheat Sheet).

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Forward Planning

Set a study schedule – "24x One-Hour Sessions".

1. **Set aside 1 to 2 one-hour time slots every day to study.**
2. **Study intensively one hour one chapter at a time.**
3. **Keep up the schedule of 24 times of one-hour study.**

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Long-Term Study Goals

Keep up the long-term study. Pre-study each chapter before the lecture proactively.

Building long-term memory by studying concepts visually and applying them to problem solving.

Visual – Visual – Visual,

Practice-Practice-Practice!

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Study Aides

Use the effective study aids to maximize your learning.

- **Cheat sheets - Rapid Learning's cheat sheet is a summary of key concepts and formulas at a high level, one chapter one sheet.**
- **Audio books – Rapid Learning's audio book is the audio version of the visual tutorial. Study anytime anywhere on-the-go. Use the audio as a trigger to exercise your memory recalling mechanisms.**
- **eBooks – Rapid Learning's ebook is the print version of the visual tutorial. Use these picture books for a high level review to recap what you learned.**

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AP Test-Taking Strategies

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Test Taking Tips

Follow these steps during the test:

- Know the basic layout of the test before you take the test.
- Plan your attack the minute the test begins.
- Use focusing techniques to improve your score.
- Apply techniques to eliminate incorrect answers.
- If you don't know the answer, make an educated guess.

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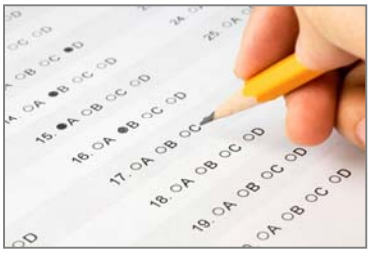
Test Day Tips



To prepare for test day:

- Arrive early and come prepared.
- Double-check the time and location of the test.
- Have a backup alarm clock just in case.
- Prepare two permitted calculators with working batteries.
- Arrive early for the test.

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Know the Test Format

By the time you take the exam, you should:

- Memorize the instructions.
- Memorize how the test proceeds.
- Know the number of questions in each section and the time allotted for each section.
- Know what types of questions are in each section.

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Plan Your Attack

Plan your attack: Spend at least 30 seconds going through the questions at the beginning of a section.

Pace yourself using your watch, after making a mental note of the half-way point and when you should be there.

Set a time limit for each question. Divide the total time allowed by the number of test questions to estimate the time limit per question.

A good limit is about 1 or 2 minutes to answer each question.

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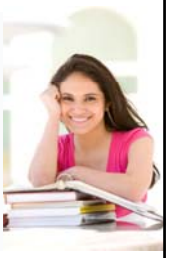
Multiple Choice Exam Tips



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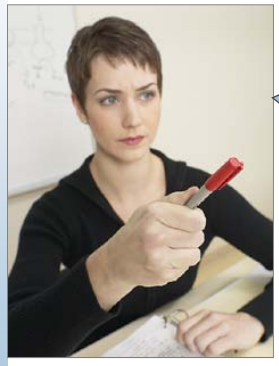
Multiple Choice Exam Tips



Maximize your score in multiple choice questions:
1. Don't waste time on any one question – move on;
2. Make an education guess by elimination;
3. Scan all answer choices before selecting;
4. Avoid word traps and beware of absolutes;
5. Pay attention to single-select and multi-select questions.

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Choose the Best Answer

Review all the answers before you choose one, more than 1 might be correct. However, make sure you choose the "best" answer for a multiple choice discrete question.

Example: *Which of the following statements best defines Newton's First Law?*

A. Every object is in motion.
B. Every object continues in motion, in a straight line.
C. Object motion is not effected by its surroundings.
D. Once an object is in motion, it will continue in motion until acted upon by an outside force.

While choice B is part of Newton's first law, what's missing is the fact that the motion will continue until an outside force acts upon the object to change its motion.

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Free Response Exam Tips

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Free Response – Exam Tips

Tips to score high in free response section:

1. Give your answer, including units and the correct significant figures;
2. Use the equation sheet and given constants;
3. Show work, all your work;
4. Answer the whole question, only the question;
5. Learn to "explain", not just rephrase the question;
6. Do what you can for partial credit.

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Free Response - Example

In an airbag test, a 80 kg crash test dummy hits a stationary air bag. The velocity of the crash test dummy at the instant of impact is 20 m/s. After 0.2 seconds, the test dummy has come to a complete stop and the airbag has deflated.

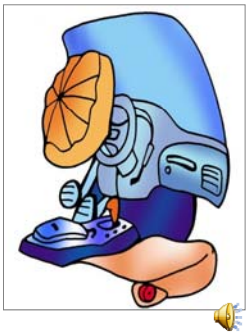
(A) What is the relationship between the average force and momentum in this problem?
(B) What (approximately) is the average force on the test dummy during this interval?

For (A), the average force is equal in magnitude to the change in the momentum of the crash test dummy divided by the elapsed time.

To answer (B), you must calculate the average force: $\bar{F} = \frac{m\Delta V}{\Delta t}$

Average force = (80 kg) (20 m/s) / 0.20 s

Average force = 8000 Newtons.



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Free Response - Questions

Answer the whole question, including each sub-part. However, don't give extraneous information to show everything you know about a topic! It won't get you any more points!

As extra information is given, the odds of including an incorrect statement increase. Also, you can spend so much time writing everything you know, you might miss answering the actual question.

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Re-Read and Proofread

After you have written your free response answer, re-read each question and sub-question to ensure you have answered everything and not missed a part.

Once your satisfied you have completely answered the question and any sub-questions, proofread your answers. This will ensure you actually wrote what you intended, and prevent unnecessary mistakes.

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Free Response Scoring Guide

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Grading Guidelines for Free Response

There is space provided to write your answer and show your work or justification for each part of the free response question. It's very important to show all your work to get full credit. Also, any errors must be erased; there is no credit given for crossed-out work, even if it was correct.

Credit for the answers in this section of the test depends on the quality and completeness of the responses. Partial credit can be awarded for partial solutions. Also, correct answers without supportive work may lose credit. This is especially true for questions that ask the student to justify the solution or answer. The points for each part of the free response question are clearly stated. An example question is shown on the following slide.

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Free Response Grading Example

The plate on the bottom of a microwave specifies that it should be connected to a 110 V supply and will draw 6000 mA.

(A) What is the net resistance of the microwave? (2 points)
(B) If the voltage dropped to 90 V, how would the current change. (2 points)

(A) In order to get full credit for this part, you must correctly rearrange Ohm's law to calculate the resistance. Also, a point would be awarded for converting mA to Amps.

$I = V / R$

$R = V / I$

$R = 110V / 6A = 18.33\Omega$

Next, for (B) you must correctly substitute the resistance calculated in (A) into the equation for current:

$I = V / R$
$I = 90V / 18.33\Omega = 4.9A$

Remember, recognize what is being asked, and what each part of the free response question requires for full credit.

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Tips for Full Credit on Free Response

The following are some tips to maximize your score on this portion of the test: Read the Problem Carefully - Be sure that you understand exactly what it is that you are asked to do in the problem. Be sure to include all necessary steps for solving the problem so a complete answer is given.

Keep an eye on the time. It is easy to lose track of time with free response questions. If you find yourself spending a lot of time on one question, skip it and come back to it later.

When you encounter a question that asks you to "justify" your answer or "determine" something, remember these words have precise meanings. When these questions are marked, you need to include equations, diagrams or graphs to support your answer and get full credit.

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Learning Summary

The new AP Physics 1&2 are designed to be the balanced integration of content knowledge and science practices, centered at the seven big ideas.

Advanced Placement (AP) Physics is a College General Physics course offered to high school students. An exam is taken at the end to obtain a college credit.

Use your calculator and given equation sheet and constants. Get comfortable with doing simple calculations without a calculator!

AP Physics 1 is an algebra-based physics course in high school, equivalent to 1st semester general physics in college.

AP Physics 2 is also an algebra-based physics course in high school, equivalent to 2nd semester general physics in college.

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