


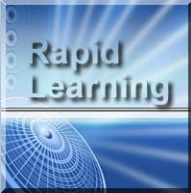
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Teach Yourself
AP Physics B in 24 Hours





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 **Introduction to
AP Physics B**

Physics Rapid Learning Series


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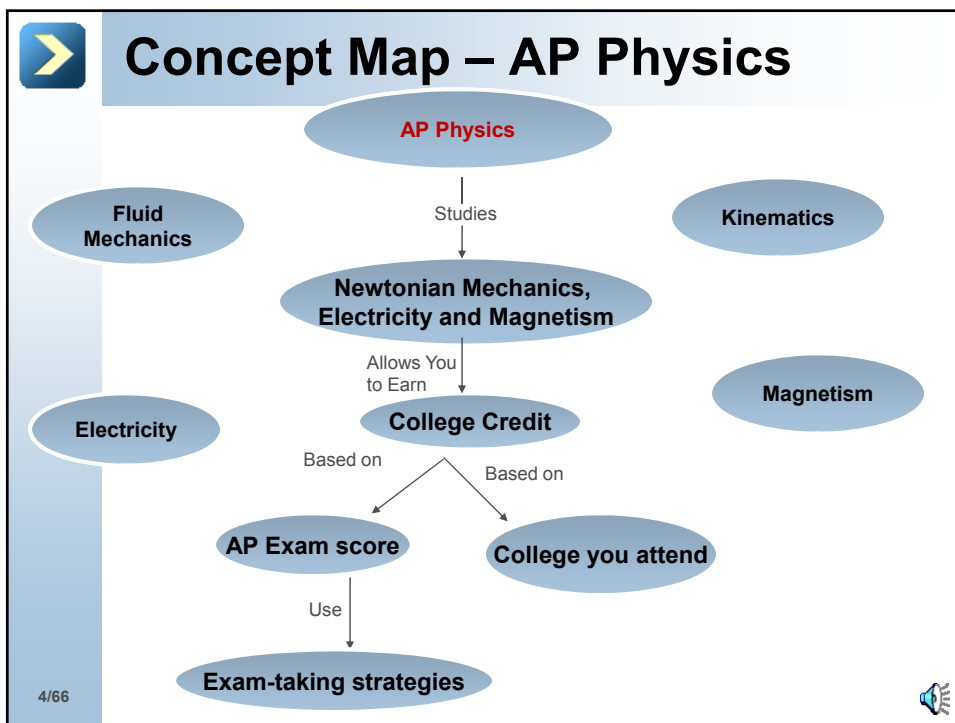
Learning Objectives


By viewing this tutorial, you will learn about:




- What AP Physics is.
- What the AP Exam is.
- AP Physics B vs. C
- AP Physics B Exam Content Outline
- How to Study AP Physics
- AP Test-Prep Strategies
- AP Exam-Taking Strategies

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What is AP Physics?

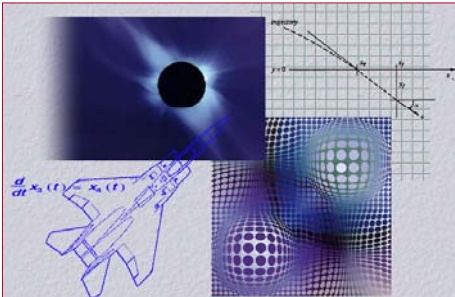



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> AP Physics

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.

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What is the AP Exam?

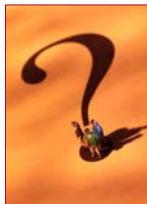


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AP Physics Exam

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. Two portions of the AP Physics exam are: (1) Physics B – 3 hrs. long in total, 70 multiple choice questions (90 minutes), 7 free response questions (90 minutes); and (2) Physics C – made up of 2 exams (Mechanics, Electricity and Magnetics). Both of these 2 exams are 90 minutes long, 45 minutes for multiple choice questions and 45 minutes for free response questions.



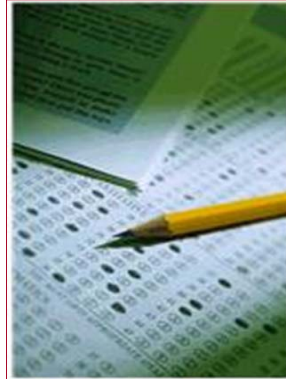
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Scope of the Exam

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

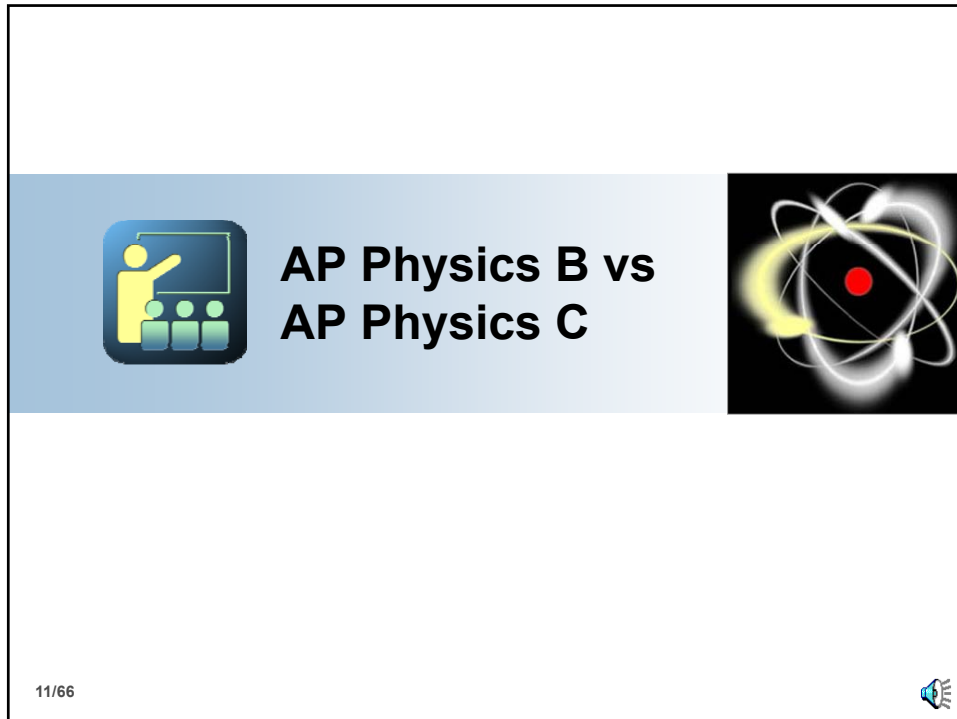
The AP Physics exam is made up of two types of questions: multiple choice and free response. There are 70 **multiple choice** questions that test conceptual understanding and must be completed in 90 minutes. There may be information contained in a paragraph, table or figure for each question and there are 5 possible answer choices.



The exams also include 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. There are usually 6 or 7 free response questions to be completed in 90 minutes.

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AP Physics B vs AP Physics C

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Course of Objects: AP Physics B&C

The category A course provides the conceptual framework required for the problem-solving and deep physics concepts in the **category B&C courses**. As such, the category A course is a good basis for the more advanced and in-depth category B&C.



The AP physics B 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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Topical Comparison of AP Physics B&C

The **Physics B Exam** covers the following topics: mechanics, electricity and magnetism, fluid mechanics and thermal physics, waves and optics, atomic and nuclear physics. The results are reported as a single grade between 1 and 5.



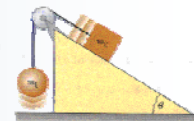
The two **Physics C Exams** are divided into: mechanics and the other covers electricity and magnetism. These exams can be taken separately, and separate grades are reported.

There are fewer topics covered in the Physics C exams, as compared to the Physics B exam. However, the Physics C exams are more in-depth and typically more difficult. Check the official exam guide for a complete comparison.

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AP Physics B Exam - Content Outline



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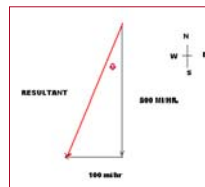


Kinematics

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.

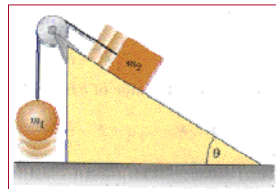


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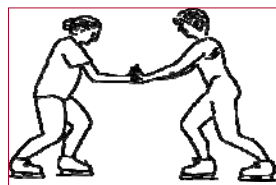


Newton's Laws

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.

$E_k = 1/2mv^2$ 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.

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

$W = \text{work}$
 $t = \text{time}$



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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.

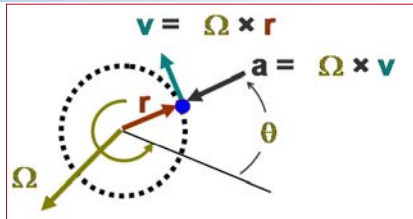


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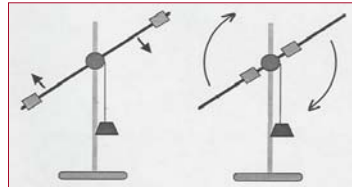


Circular Motion and Rotation



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.



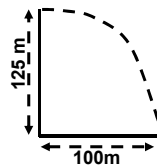
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Multiple Choice Question: Kinematics

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
- E. 125 m/s



The initial speed of the car is calculated by using the equation describing the horizontal motion of the car (i.e. $X = v_{ox}t$). $V_{ox} = 100/t$, $t = \text{time}$. $Y = 125 - \frac{1}{2}gt^2$. The ground is $y = 0$. $V_{ox} = 100/5 = 20 \text{ m/s}$.

20/66





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.



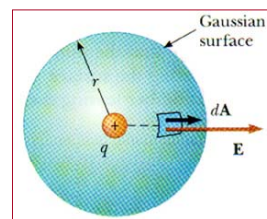
Buoyancy is the upward force that keeps objects afloat, the net upward force is equal to the weight of water (fluid) displaced by the object.

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Electricity and Magnetism

Electrostatics is the study of stationary, or slowly moving, electric charges. In this study, Coulomb's law is a mathematical description of the electric force between objects.



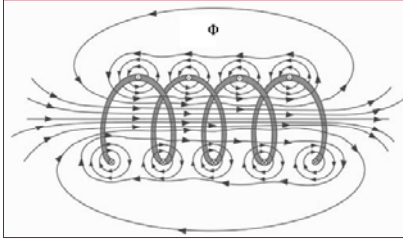
Gauss's law: relates the distribution of electric charge and the resulting electric field. The electric flux through an area is defined as the electric field multiplied by the area perpendicular to the field.

22/66





Electromagnetism



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

Magnetic flux (quantity of magnetism) = $\Phi B A \cos\theta$

There are a number of terms and laws associated with Electromagnetism, including: (1) Permittivity, (2) Faraday's Law – the induced EMF in a closed circuit is equal to the time rate of change of magnetic flux through the circuit, (3) tesla, (4) volt, and (5) farad.

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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.

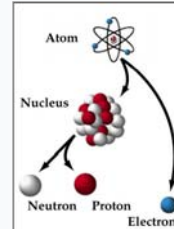


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Waves, Optics, and Atomic Physics



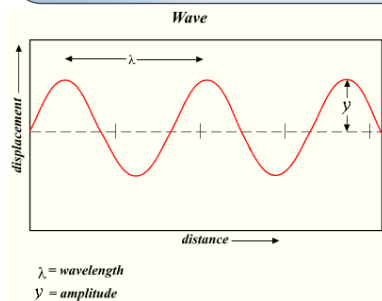
1. Wave Motion
2. Optics
3. Atomic Physics
4. Nuclear Physics

25/66



Wave Motion

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 ways 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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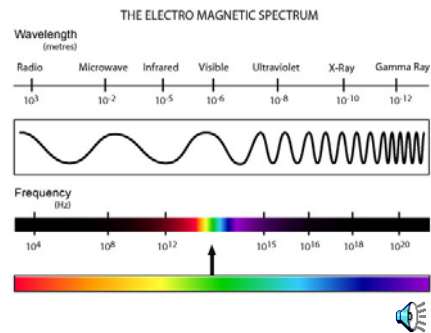


Optics

The study of the behaviour and properties of light is known as **optics**. Optic equipment includes: mirrors, lenses, telescopes, lasers and fiber optics. When light breaks into its component parts, it's known as diffraction. The reflection of light can occur from glossy surfaces, such as a mirror, or diffuse from surfaces, such as glossy paint.



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



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 \AA to 1000 m . Within this spectrum is the visible light range from approximately 380 nm to 720 nm .



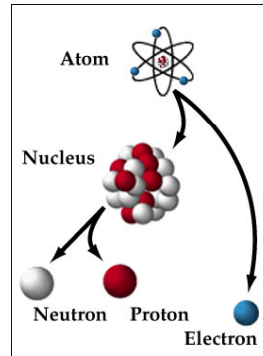
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Atomic Physics

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.



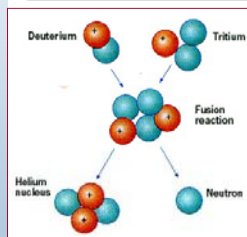
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Within multi-electron atoms, such as helium, there can be different energy levels for its electrons and these can be described with an atomic energy level diagram. Electrons can be in a ground state or, under the right conditions, an excited state.



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.

30/66





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

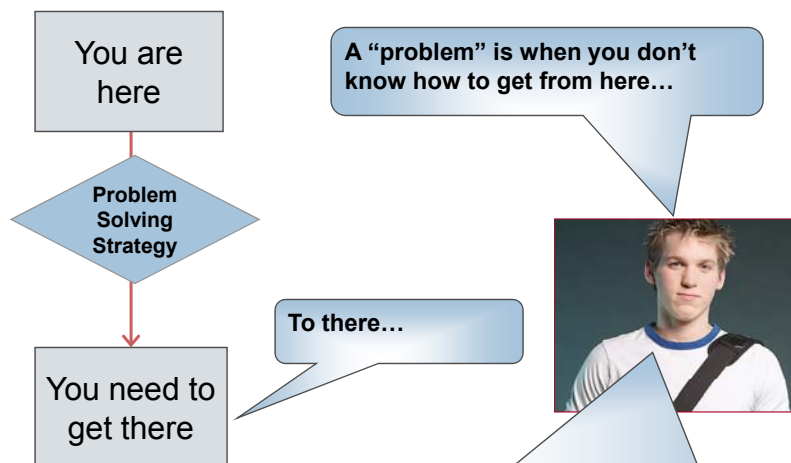
Everything may not make sense all at once. **Focusing on the concepts** and how these concepts fit into the big picture will help you succeed in AP Physics. In physics, often the question will be based on the actual concept, as opposed to the overall action.



35/66



What is Problem-Solving?



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

36/66





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:

$$E_k = 1/2mv^2$$

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

$$E_k = 90000 \text{ Joules}$$

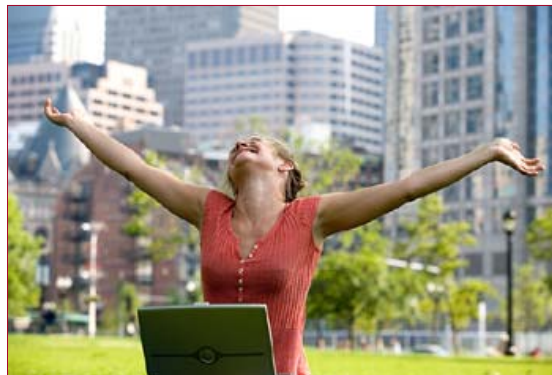


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Practice - Practice - Practice

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

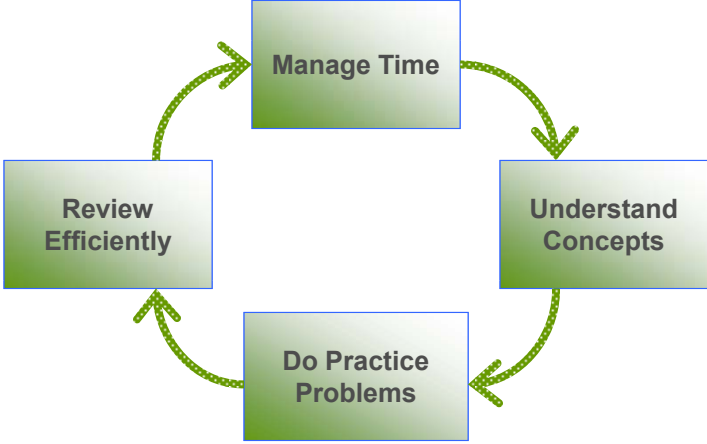


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Four-Step Review Process

Follow this four-step process to successfully study and prepare for AP Physics exam.



```

graph TD
    A[Manage Time] --> B[Understand Concepts]
    B --> C[Do Practice Problems]
    C --> D[Review Efficiently]
    D --> A
    
```

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Forward Planning

Plan ahead: Set a study schedule



1. Set aside some time slots every day to study.
2. Do NOT put off your study schedule.
3. You need to practice EVERY DAY in the coming weeks and months.

41/66



Long-Term Study Goals

Some students incorrectly believe that if they study more as the test date approaches, they will remember more.



Building long-term memory by studying in set doses ahead of time increases memory and the understanding of concepts.

If you cram too much information and make yourself nervous the night before the exam, you might get into a “mental indigestion.”

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Study Aides

Use the following aides to help you study:

- **Cheat sheet** - A cheat sheet is a summary of what you learned. It should include key terms and concepts.
- **Flash cards** - Flash cards are index cards with a question on one side and the answer on the other side. Test yourself by using the flash cards. Be brief, do not write in detail, and **DO NOT BUY** pre-made flash cards!



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AP Test-Taking Strategies



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Test Taking Tips

Follow these steps during the test:

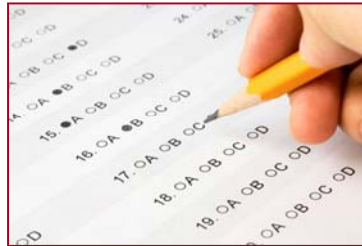
- Know the basic layout of the test before you take the test.
- Plan your attack the minute the test begins.
- Use focusing techniques to improve your score.
- Apply techniques to eliminate incorrect answers.
- If you don't know the answer, make an educated guess.



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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.
- Arrive at least 15 minutes 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.

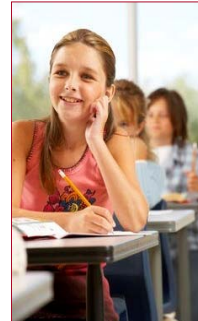


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Plan Your Attack

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

Don't waste time on any one question. The difficulty does increase, in general, but you may be more familiar with some of the later topics. The test is written so that you won't know everything; don't waste time on questions that are obviously ones you haven't studied. Move on and come back if there's time at the end!

Don't leave any question blank. There is no longer any guessing penalty in AP tests. Do not skip any question. No points are awarded for answers left blank. You will always get the wrong answer if you don't fill in any choice. Take an educated guess.

Answer ALL questions. You will be rewarded.



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Math Requirements for AP Physics B

The AP Physics tests will draw on your mathematic skills as a tool to solve the physics question, not as a test of your math abilities. The mathematics required to be successful on the AP Physics B test include: **Algebra** – including solving for unknown variables, such as x in this question: $46 = 47 + -1x$. Knowledge of equation basics, proportion basics, and combining similar terms and exponents of variables will be helpful to your success on this test.

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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Free Response Tip – Calculator Use

As there is no calculator allowed during the multiple-choice section of the exam, you need to get comfortable with doing simple **calculations without a calculator!**

For example:

Simple multiplication and division, including decimals (e.g., $0.05 \times 0.1 = 0.005$)

Look for cancellations to simplify your calculations and calculate with scientific notation.



However, during the free response section graphing and programmable calculators are permitted to be used. Although, devices such as a powerbook, palm, or PDAs are prohibited.

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Multiple-Choice Exam Format

The exam is divided into a multiple-choice and a free response section. The **multiple-choice questions** are designed to test concepts and applications. The basic definitions and principles of physics will be included. Included in the exam packet is a table of information and equations.



Due to the fact that calculators are not permitted during the multiple-choice questions, the calculations required to answer certain questions will be simple and involve estimation.

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Free Response Tip – Show Work!

Show all your work in the free response section. The readers or graders of the exam are not allowed to assume that you know something...make it clear that you know it by showing it! Show the equation you're going to use. Show the numbers plugged into the equation. Give your answer, including units and the correct significant figures!



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Free Response Tip - Equation Sheet

The AP exam gives you an equation sheet for both the Physics B and Physics C exams. They can be downloaded from the following website:

http://www.collegeboard.com/student/testing/ap/sub_physb.html

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!

TABLE OF INFORMATION FOR 2008 and 2009 CONSTANTS AND CONVERSION FACTORS	
Proton mass, $m_p = 1.67 \times 10^{-27}$ kg	Electron charge magnitude, $e = 1.60 \times 10^{-19}$ C
Neutron mass, $m_n = 1.67 \times 10^{-27}$ kg	1 electron volt, $1 \text{ eV} = 1.60 \times 10^{-19}$ J
Electron mass, $m_e = 9.11 \times 10^{-31}$ kg	Speed of light, $c = 3.00 \times 10^8$ m/s
Avogadro's number, $N_0 = 6.02 \times 10^{23}$ mol ⁻¹	Universal gravitational constant, $G = 6.67 \times 10^{-11}$ m ³ /kg·s ²
Universal gas constant, $R = 8.31$ J/(mol·K)	Acceleration due to gravity at Earth's surface, $g = 9.8$ m/s ²
Boltzmann's constant, $k_B = 1.38 \times 10^{-23}$ J/K	
1 unified atomic mass unit, $1 \text{ u} = 1.66 \times 10^{-27}$ kg = 931 MeV/c ²	
Planck's constant, $h = 6.63 \times 10^{-34}$ J·s = 4.14×10^{-15} eV·s	
	$hc = 1.99 \times 10^{-25}$ J·m = 1.24×10^3 eV·nm
Vacuum permittivity, $\epsilon_0 = 8.85 \times 10^{-12}$ C ² /N·m ²	
Coulomb's law constant, $k = 1/4\pi\epsilon_0 = 9.0 \times 10^9$ N·m ² /C ²	
Vacuum permeability, $\mu_0 = 4\pi \times 10^{-7}$ (T·m)/A	
Magnetic constant, $k' = \mu_0/4\pi = 10^{-7}$ (T·m)/A	
1 atmosphere pressure, $1 \text{ atm} = 1.0 \times 10^5$ N/m ² = 1.0×10^5 Pa	

54/66

Portion of the Equation Table





Free Response Example

In an airbag test, a 80kg 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?

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) / 0.20s

Average force = 8000 Newtons.



55/66



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.

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.
- E. Answer A and B are both correct.

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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Question: Challenge

What are 2 tips for the multiple choice section of the exam, reviewed in this tutorial?

(1) **As there is no calculator allowed during the multiple-choice section** of the exam, you need to get comfortable with doing simple calculations without a calculator, and (2) **Scan all the choices** before selecting one...more than one might be correct, but one might be better.



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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 essay answer, **re-read each question and sub-question** to ensure you have answered everything and not missed a part.




Once you are 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 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.

$$I = V/R$$

$$R = V/I$$

$$R = 110 \text{ V} / 6 \text{ A} = 18.33 \Omega$$

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

$$I = V/R$$

$$I = 90 \text{ V} / 18.33 \Omega = 4.9 \text{ A}$$

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

A **wave** is a periodic disturbance through which the sound or water wave travels. Waves can lead to reflection, refraction, interference and dispersion.

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.

The **photoelectric effect** was discovered by Heinrich Hertz and later explained by Albert Einstein.

As there is **no calculator** allowed during the multiple-choice section of the exam, you need to get comfortable with doing simple calculations without a calculator!

Electrostatics is the study of stationary, or slowly moving, electric charges. In this study, Coulomb's law is a mathematical description of the electric force between objects.

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Congratulations

You have successfully completed
the tutorial

**Introduction To
AP Physics B**

Rapid Learning Center


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Chemistry :: Biology :: Physics :: Math

What's Next ...

Step 1: Concepts – Core Tutorial (Just Completed)
→ Step 2: Practice – Interactive Problem Drill
Step 3: Recap – Super Review Cheat Sheet

Go for it!

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