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Barron's

物理C 2008

Barron's AP
Physics C 2008
2nd Edition

:: 备考指南 考点透析

:: 1套诊断测试助您认清强弱项

:: 2套全真测试题帮您考前热身

Robert A. Pelcovits, Ph.D. and Joshua Farkas, M.D.

世界图书出版公司

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Contents 目录

Introduction 绪论

HOW TO REVIEW FOR THE AP PHYSICS EXAM 如何复习AP物理考试

Solving physics problems is like mastering any sport or musical instrument: If you want to do it well, you have to practice. Do not expect to understand everything immediately and do not be frustrated by the effort required to master some concepts and techniques. Contrary to popular conceptions of a vast divide between physics geniuses who can immediately solve problems and other people who simply cannot, learning physics requires hard work. However, a mastery of calculus-based physics will teach you analytical and mathematical skills that will prove extremely useful in a broad range of other disciplines.

GUIDE TO THIS REVIEW BOOK 本书指南

Text 正文

The text of the chapters works from the ground up without assuming extensive knowledge of physics on your part. Therefore, the text is appropriate at any stage of your mastery of AP physics. You may find it helpful to read the text along with your textbook when you are first learning the material and studying for course exams, or you may choose to read the chapters together as a review after you have completed most of your AP physics course.

Questions 题目

Because of space limitations, it is impossible for the questions to work from the ground up (i.e., start with very easy questions and progress to more difficult ones). Therefore, the questions are generally near the AP level and assume that you have some problem-solving experience. The questions are designed to raise you from a competent problem solver to an expert with extensive experience in solving AP problems. If you have difficulty with the questions, you may want to go back and solve some problems in your introductory physics textbook or AP physics textbook, as well as consider the advice in the next paragraph.

Difficulty of the Questions 题目难度

The problems in this review book are generally slightly more difficult than actual AP exam questions. In order to maximize the amount that you learn from this book and your degree of comfort with AP physics questions, we have designed the questions to cover the material and problem-solving techniques of the AP physics exam while being more challenging than questions you are actually likely to encounter on the exam. For example, our problems generally have more parts than standard AP problems in order to exhaustively explore various hypothetical situations. Therefore, we strongly urge you not to become discouraged if you are not able to solve all the problems on your first attempt. Instead, the best approach is to make your best effort at the problems, read (and study) the solutions of problems you got wrong, and later return to these problems and try them again. Because we have attempted to include all the common problem types that appear on the AP exam, after you have worked through all the problems in this guide correctly (even if not on your first or second attempt), you will probably be in excellent shape. Another approach that you might find useful for multistep problems is to do each part individually and check the answer before proceeding to the next part. This allows you to avoid wasting time by making a mistake in one part and then propagating it through the rest of the problem.

The advantage to this difficulty level is that after you obtain experience solving the problems in this book, you will be comfortable solving the problems on the AP exam.

Distribution of the Questions 题目分布

Not all AP topics are created equal. Some topics (such as Gauss's and Faraday's laws) are tested extensively and are frequently the subject of entire free-response questions. Other topics (such as circuit analysis) are central to solving a range of questions but are generally not the sole topic of a free-response question. Finally, some topics (such as Maxwell's equations) are not tested very extensively.

The distribution of questions in this review book is based on a careful review of decades of AP examinations. Topics that have been tested frequently in the past are reviewed thoroughly, and topics are tested infrequently are not reviewed as extensively. Additionally, more attention is paid to topics requiring more practice than others. (For example, although rotational kinematics is frequently tested, extensive practice with rotational kinematics is not crucial because of its similarity to linear kinematics.) We appreciate that the time you have to review for this exam is limited, so we have worked hard to provide you with exactly the material and questions you need to do well on the AP exam.

Derivations 推导

From introductory physics courses, you may have received the impression that derivations aren't very important but rather that only the final results are relevant. This is not the case in Physics C, where the level of sophistication is high enough to require the derivation of most of the important equations. Since these derivations illustrate important principles and problem-solving approaches, we have included them here and urge you to make sure you understand them.

Problem-Solving Strategies to Watch For 值得注意的应试技巧

As multiple-choice and free-response questions are presented and explained, we have tried to show, often in multiple approaches to the same problem, how various strategies can be applied. A quick way to answer a multiple-choice question, for example, often involves elimination of incorrect choices based on such considerations as dimensional analysis, behavior at extreme values of the system parameters, results of eliminating certain parameters, and the absence of parameters that by the nature of the problem must be included. In the free-response questions, results from previous parts frequently are used in later, more involved, parts; thus, notice how you can get valuable clues as to how to approach part (d) by rereading (and probably using results from) parts (a), (b), and (c). Remember the value of getting a good grasp of the situation described in a problem; using sketches, diagrams, and graphs;

thinking of the relationships between given quantities; and relating situations to concepts that might be more familiar (as in rotational and linear motion, in electrical and gravitational fields, and in conservation of elastic and gravitational energy). As you carefully study our solutions, be sure to watch for these and the many other approaches that will improve your abilities to analyze and to understand physics problems and to develop your "physics intuition."

DESCRIPTION OF THE AP PHYSICS C EXAM AP物理C考试是什么

You are probably familiar with the concept of AP testing, which provides the opportunity to receive recognition for college-level coursework. While each college and university interprets AP scores (graded from a low of 1 to a high of 5) differently, good scores generally translate into college credits and advanced placement. (Note that you can miss many questions and still earn a score of 5.) Commonly, matriculation into many college courses without having had the experience of studying for the appropriate AP exam may place you at a severe disadvantage. Furthermore, college admissions committees tend to value applicants who have completed AP testing or have scheduled AP courses with the intention of taking the exam. (Note that it is permissable to take an AP exam after studying for it individually, even if your school system does not offer a corresponding course labeled AP.)

The Physics C exam is somewhat different from others you may have encountered. It is divided into two separate 90-minute sections: one on mechanics, the other on electricity and magnetism. These two sections are graded independently, and each is often considered the equivalent of a semester course in college. Although we have difficulty imagining how anyone could resist the beauty of either section, you have the option of taking either the mechanics or the electromagnetism test alone. This organization is reflected in this book, which is similarly divided between the two topics. Each half of the book includes the many examples you will need of both question types, the multiple choice and the free response, as well as three complete model tests that mirror the question types and the distribution of topics likely to be encountered. Once the basic material is understood, careful study of the questions and solutions in this book will leave you well prepared for any questions on the actual exam.

Each of these two exams is divided evenly, by time and by contribution to grading, between a multiple-choice section and a free-response section. The 35-question multiple-choice section does *not* permit the use of calculators and often lends itself to intuitive understanding, symbolic manipulation, and estimation by orders of magnitude. Both sections of the exams include a Table of Information indicating numerical values of physical constants and conversion factors. The free-response section permits most programmable or graphing calculators and does not require that memories be erased. This half of the test also allows the use of an included equation table (reproduced at the end of this guide). While this reference information provides a handy memory check and a source of ideas for solutions, we do not recommend that you rely on it: Many equations are omitted, finding needed equations uses valuable time, and lack of mastery of the basics will hamper your thinking. Although the College Board states that in the future there may be a larger number of shorter questions (as opposed to the traditional three questions) on the free-response half of the exam, they will remain similar in difficulty, topic, and solution methods. As in the past, concepts from many areas of physics are often involved in each question. Carefully recording your work within the booklet (including the general laws and equations being used) is crucial for full or partial credit, as is the inclusion of units in final answers.

The topics covered on the Physics C exam and the percentage goals listed by the College Board are as follows (as you can take either the mechanics or electricity and magnetism exams separately, we have totaled each part to 100%):

I. Newtonian Mechanics	
• Kinematics	18%
• Newton's Laws of Motion	20%
• Work, energy, and power	14%
• Systems of particles, linear momentum	12%
• Circular motion and rotation	18%
• Oscillations and gravitation	18%
II. Electricity and Magnetism	
• Electrostatics	30%
• Conductors, capacitors, dielectrics	14%
• Electric circuits	20%
• Magnetic fields	20%
• Induction and Maxwell's equations	16%

Further information about the AP Physics C exam can be found at the College Board web site, which includes recent tests and an extensive guide to the exam containing sample questions (http://www.collegeboard.org/ap/physics/).

OTHER USES OF THIS BOOK 本书的其他用途

Despite our careful modeling of this book to reflect the Physics C exam, it is also an invaluable aid for anyone taking courses in calculus-based mechanics or electromagnetism. Solving physics problems is what physics courses are generally about, and solving physics problems is what this book will teach you. Since it is hard to imagine any college physics exam that doesn't involve some combination of multiple-choice questions and more extensive problems, many test-taking strategies discussed in this guide should apply as well.

WHAT DO *YOU* THINK? 您有什么想法？

I am continually striving to improve this review book, so I welcome any questions or comments you might have, particularly those concerning errors or deficiencies in this edition. Please feel free to contact me either by ordinary mail or electronically. Your thoughts are greatly appreciated.

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Providence, RI 02912
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Good luck!

Answer Sheet

答题纸

DIAGNOSTIC TEST

诊断测试

Mechanics 力学

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Electricity and Magnetism 电磁学

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Diagnostic Test 诊断测试

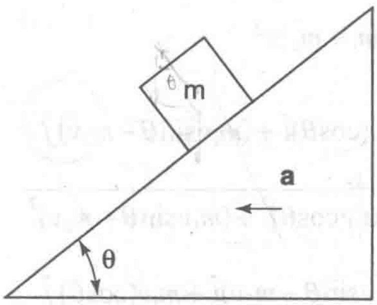
MULTIPLE-CHOICE QUESTIONS 选择题

Directions: Each multiple-choice question is followed by five answer choices. For each question, choose the best answer and fill in the corresponding oval on the answer sheet. You may refer to the formula sheet in the Appendix (pages 781–784).

Mechanics 力学

1. A block lies on an inclined plane with angle of elevation θ, as shown in the figure. The inclined plane is frictionless, and the plane is accelerated to the left such that the block's height remains constant. What is the net force on the block?

(A) $mg \cot\theta$
(B) $mg \tan\theta$
(C) $mg \cos\theta$
(D) $mg \sin\theta$
(E) zero



Question 1

2. Consider the Atwood machine shown in the figure, which consists of two masses connected to a pulley. If the pulley's mass is *not* negligible, which of the following is true of the acceleration a of each mass?

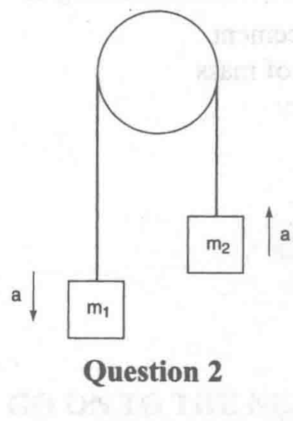
(A) $a > \left(\dfrac{m_1+m_2}{m_1-m_2}\right)g$

(B) $a < \left(\dfrac{m_1+m_2}{m_1-m_2}\right)g$

(C) $a > \left(\dfrac{m_1-m_2}{m_1+m_2}\right)g$

(D) $a = \left(\dfrac{m_1-m_2}{m_1+m_2}\right)g$

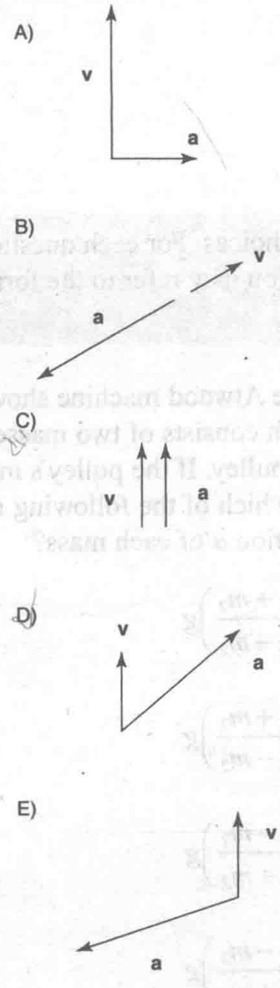
(E) $a < \left(\dfrac{m_1-m_2}{m_1+m_2}\right)g$



Question 2

GO ON TO THE NEXT PAGE ►

3. Consider the velocity and acceleration vectors shown in the figure for some object. In which would the object experience the greatest increase in speed?



Question 3

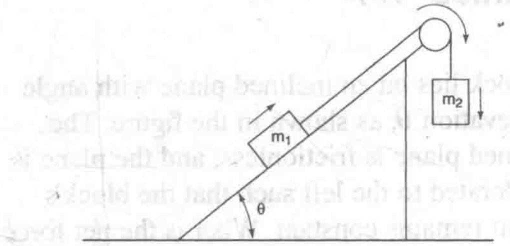
4. The moment of inertia (rotational inertia), $\int R^2\,dm$, is the rotational analog of

(A) displacement
(B) center of mass
(C) velocity
(D) mass
(E) force

5. A mass m connected to a spring with spring constant k oscillates at a frequency f. If the mass is increased by a factor of 4 and the spring constant is increased by a factor of 2, the new frequency will be

(A) $2f_0$
(B) $8f_0$
(C) $\sqrt{2}f_0$
(D) $f_0/\sqrt{2}$
(E) none of the above

Questions 6–8 refer to the figure below, which shows two masses connected by a massless pulley. Assume the incline is frictionless.



Questions 6–8

6. When the speed of each object is v, what is the total momentum of the two masses, m_1 and m_2? (Assume that the x-axis is horizontal and the y-axis is vertical)

(A) $\frac{1}{2}(m_1+m_2)v^2$

(B) $m_1v(\cos\theta)\hat{i}+(m_1v\sin\theta-m_2v)\hat{j}$

(C) $\sqrt{[m_1v\cos\theta]^2+(m_1v\sin\theta-m_2v)^2}$

(D) $(m_1v\sin\theta-m_2v)\hat{i}+m_1v(\cos\theta)\hat{j}$

(E) $m_1v\sin\theta\hat{i}+(m_1v\cos\theta-m_2v)\hat{j}$

GO ON TO THE NEXT PAGE ►

7. When m_2 has fallen a distance d, what is the change in the total kinetic energy of the system?

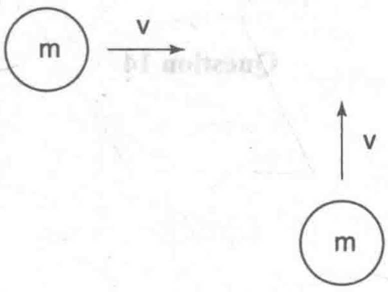
(A) $g(m_2d + m_1d\sin\theta)$
(B) $g(m_2d - m_1d\sin\theta)$
(C) $g(m_2d + m_1d\cos\theta)$
(D) $g(m_2d - m_1d\cos\theta)$
(E) Total kinetic energy is conserved.

8. Now consider that the inclined plane, which has mass M and rests on a frictionless surface, can move as well. When both small masses start from rest, which of the following quantities evaluated for the system of the three masses is conserved?

(A) gravitational potential energy
(B) kinetic energy
(C) x-momentum
(D) y-momentum
(E) There are no conserved quantities for this system.

9. Two objects with equal masses and speeds as shown collide and stick together. What is the final speed of the combined mass?

(A) $v/2$
(B) $v/\sqrt{2}$
(C) v
(D) $v\sqrt{2}$
(E) $2v$



Question 9

10. An object moving with constant acceleration in two dimensions can have how many of the following path types?

I. a linear path
II. a circular path
III. a parabolic path
IV. an elliptical path
V. a spiral (corkscrew) path

(A) none
(B) one
(C) two
(D) three
(E) four

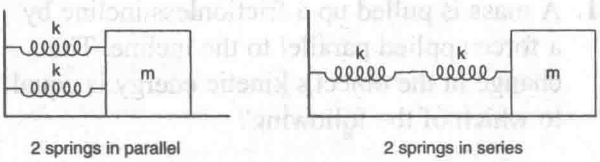
11. A mass is pulled up a frictionless incline by a force applied parallel to the incline. The change in the object's kinetic energy is equal to which of the following?

(A) the negative of the change in potential energy
(B) the work done by gravity
(C) the work done by the applied force
(D) the work done by the applied force minus the work done by gravity
(E) the work done by the applied force plus the work done by gravity

GO ON TO THE NEXT PAGE ➤

12. Which of the following changes does not affect the period of a horizontal mass-spring system undergoing simple harmonic motion?

(A) doubling the mass
(B) attaching an identical spring in parallel (as in the figure)
(C) attaching an identical spring in series (as in the figure)
(D) the presence of friction between the block and the horizontal surface
(E) any manipulation of the masses and springs that does not affect the ratio of the maximum amplitude to the maximum velocity

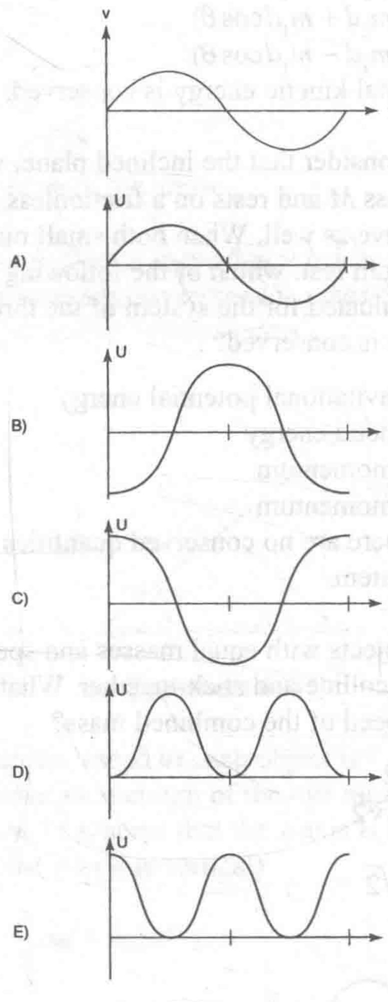


Question 12

13. As a block moves up an incline at constant speed, the frictional force performs −5 J of work on the block. As the block moves down the same incline at constant speed, how much work does the frictional force perform on the block?

(A) −5 J
(B) 0 J
(C) +5 J
(D) It depends on the angle of elevation of the incline.
(E) It depends on whether the applied force is the same in both situations.

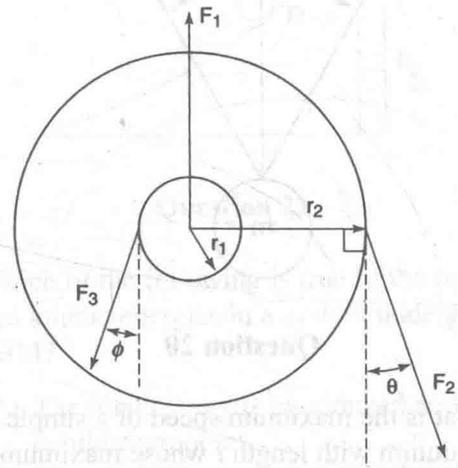
14. The velocity as a function of time for an object undergoing simple harmonic motion is shown. Which of the following graphs shows the potential energy as a function of time?



Question 14

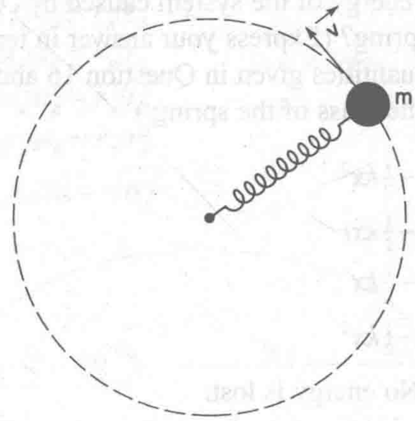
15. Consider the two concentric cylinders in the figure, which are fastened to each other and suspended by a pin through their center, which exerts a force of F_1. Two additional forces, F_2 and F_3, act on the cylinders as shown. Which of the following equations is a necessary condition for the two-cylinder system to remain in static equilibrium?

(A) $F_1 - F_3 \sin\phi - F_2 \sin\theta = 0$
(B) $F_1 - F_3 \cos\phi + F_2 \cos\theta = 0$
(C) $F_2\cos\theta - F_3\cos\phi = 0$
(D) $F_2(\cos\theta)r_2 - F_3(\cos\phi)r_1 = 0$
(E) $F_2(\cos\theta)r_1 - F_3(\cos\phi)r_2 = 0$



Question 15

Questions 16–18 refer to the figure below, which shows a mass m *connected to a spring (of spring constant* k*) rotating in a circle on a frictionless table.*



Questions 16–18

16. If x is the extension of the spring, v is the speed of the mass, and r is the radius of the circular path, which of the following equations is valid?

(A) $kx = mv^2/2$
(B) $kx^2/2 = mv^2/2$
(C) $kx^2/2 = mv^2/r$
(D) $kx = mv^2/r$
(E) None of the above equations are valid.

17. In terms of the mass m, the spring constant k, the extension of the spring x, and the radius of the circle r, what is the rate at which the spring does work on the mass?

(A) $kx\sqrt{kxr/m}$
(B) $kx\sqrt{m/kxr}$
(C) $kx(kxr/m)$
(D) $kx(m/kxr)$
(E) zero

GO ON TO THE NEXT PAGE ►

18. Imagine that the spring in the figure is suddenly cut, causing the mass to continue along a path tangential to its motion at the instant the spring is cut. What is the change in the total energy of the system caused by cutting the spring? (Express your answer in terms of the quantities given in Question 16 and neglect the mass of the spring.)

(A) $-\frac{1}{2}kx^2$

(B) $-\frac{1}{2}kxr$

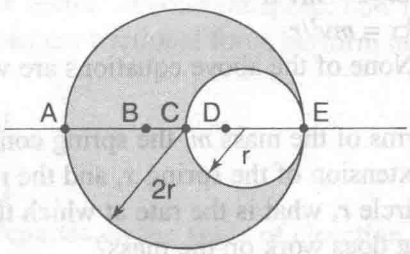
(C) $-\frac{1}{2}kx$

(D) $-\frac{1}{2}kx^2$

(E) No energy is lost.

19. Consider a disk that has uniform density and a hole as shown. Where is the center of mass of this disk located?

(A) point *A*
(B) point *B*
(C) point *C*
(D) point *D*
(E) point *E*



Question 19

20. A mass *m* is suspended by two ropes as shown. What is the tension in each of the ropes?

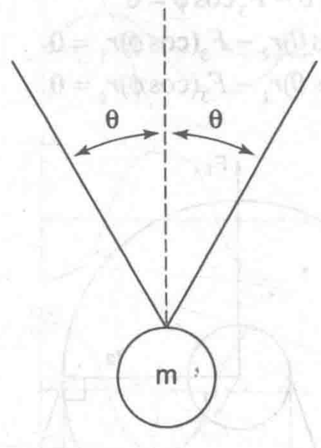
(A) $F_T = \frac{1}{2}mg\sin\theta$

(B) $F_T = \frac{1}{2}mg\csc\theta$

(C) $F_T = \frac{1}{2}mg\cos\theta$

(D) $F_T = \frac{1}{2}mg\sec\theta$

(E) $F_T = 2mg\cos\theta$



Question 20

21. What is the maximum speed of a simple pendulum with length *l* whose maximum angle of displacement from the vertical is θ?

(A) $\sqrt{gl\cos\theta}$

(B) $\sqrt{2gl\cos\theta}$

(C) $\sqrt{gl(1-\cos\theta)}$

(D) $\sqrt{2gl(1-\cos\theta)}$

(E) Not enough information given.

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