出国留学书系
SAT、AP备考书系

最新版

AP Barron's

物理B

（第4版）

Jonathan S. Wolf

世界图书出版公司

AP Barron's
物理B
（第4版）

世界图书出版公司
北京·广州·上海·西安

图书在版编目(CIP)数据

Barron's AP 物理 B(第 4 版)/(美)乔纳森(Jonathan S. Wolf)编著;余跃译.—北京:世界图书出版公司北京公司,2011.1
(Barron's AP 系列)
书名原文:Barron's AP Physics B
ISBN 978-7-5062-9523-9

Ⅰ.①B… Ⅱ.①乔… Ⅲ.①物理—高等学校—入学考试—美国—自学参考资料—英文
Ⅳ.①O4

中国版本图书馆 CIP 数据核字(2010)第 233716 号

Barron's AP Physics B with CD-ROM(4th Edition) by Jonathan S. Wolf.

ISBN:978-0-7641-9351-4

This edition arranged with BARRON'S EDUCATIONAL SERIES, INC. through BIG APPLE TUTTLE-MORI AGENCY, LABUAN, MALAYSIA.

Barron's AP 物理 B (第 4 版)

原 书 名:Barron's AP Physics B
编 著 者:Jonathan S. Wolf
译 者:余 跃
责任编辑:张颖颖

出 版:世界图书出版公司北京公司
出 版 人:张跃明
发 行:世界图书出版公司北京公司
(地址:北京市朝内大街 137 号 邮编:100010 电话:64077922)
销 售:各地新华书店及外文书店
印 刷:三河市国英印务有限公司

开 本:880 mm × 1230 mm 1/16
印 张:32.75
字 数:858 千
版 次:2011 年 1 月第 1 版 2011 年 1 月第 1 次印刷
版权登记:京权图字 01-2010-7462

ISBN 978-7-5062-9523-9/G · 435 **定价**:79.00 元(含 1 张 CD-ROM)

Preface 前言

In this review book, you will be taught several strategies for making your learning and studying more efficient. These are skills that will always be useful and that you can apply across the curriculum for many different subjects.

Each topical review chapter contains ten multiple-choice questions that differ in variety, style, and level of difficulty. Their purpose is to provide you with a balanced set of questions that test your level of understanding of the review material. Some questions may be easier or more difficult than the actual AP Physics B exam questions because, unlike the actual test, which covers a broad range of subjects, each chapter in this book deals with a specific topic. In addition to the multiple-choice questions there are free-response problems that also vary in difficulty. Full solutions and explanations follow the questions. Additional problem-solving strategies are also provided.

Before the review chapters, there is a diagnostic examination designed to measure your initial level of understanding or to use for practice. At the end of the book, two additional sample examinations are provided. Each examination is fully explained with solutions and guidelines.

This new fourth edition includes many changes. Included with some books is a CD-ROM, which has two more practice exams. Each exam now has a self-assessment scoring guide as well as a guide for score improvement. I would like to thank a student, Alex Ramek, for helping me with the score improvement guide and helping me from a student's perspective. Additionally, more sample problems have been included in each of the chapters, and the practice tests have been updated. Each content chapter review now begins with a listing of key concepts and ends with a brief summary of main ideas. My colleagues Robert Draper, Patricia Jablonowski, and Joseph Vaughan have been very helpful with insight and ideas for improvement.

I am grateful to Linda Turner, Senior Editor at Barron's Educational Series, for all her ideas and suggestions, and to my wife, Karen, and my daughters, Marissa and Ilana, for their understanding, love, and support.

Scarsdale, New York
April 2007

Jonathan S. Wolf

Introduction 介绍

KEY CONCEPTS

- What Is Physics?
- Rules of Reasoning When Doing Physics
- Establishing Relationships in Physics
- What Is Advanced Placement Physics?
- To the Teacher

TO THE STUDENT 给学生的建议

What Is Physics? 物理是什么?

Physics is a branch of knowledge that attempts to establish relationships among natural phenomena. These observations are a part of our sense experiences from everyday life. As human beings, we use these sensory inputs to make decisions about the world around us. These decisions are based on recognized patterns of orderly events (like the rising and setting of the sun, the change in seasons, the migrations of animals, and the movement of bodies).

Occasionally, we come across situations that seem to occur randomly. These discrepant events challenge the routine of predictability that is the foundation of the scientific method. Many of these naturally occurring random events display orderly tendencies on average. This means that although individual events might be random, the occurrence of a large number of events may indeed be predictable. This statistical behavior of natural phenomena will come in handy when we consider the interactions of large numbers of interacting particles, such as a gas.

In order to understand how these causal relationships are established, we must first adopt a set of rules by which all observers might be led to similar conclusions. There is a caveat, however, in that if we restrict our decisions too rigidly, we may be forced to make conclusions that are contrary to our senses and the real world. In physics, the former happens all the time. However, the nature of science demands that we must always describe real events. It is to these "rules of reasoning" that we now proceed.

Rules of Reasoning When Doing Physics

物理学研究中的逻辑方法

The branch of knowledge that develops these rules of reasoning about the world is called **philosophy**. Philosophy differs from science in that the scientific method demands that experimental evidence verify a prediction made using the rules of reasoning (or logic) to be discussed below. Thus, the ancient Greek philosophy called φισικοσ (*physikos*) or natural philosophy, developed from abstract thinking about how the universe works to a systematic experimental discipline.

In physics, we usually employ two modes of reasoning called **inductive** and **deductive**. Inductive reasoning begins with an accumulation of specific phenomena, and we make conclusions about a general concept. This is the basis for experimental science. In a controlled experiment, we vary one quantity independently and then observe what happens to another quantity called the **dependent** quantity.

The relationship is established by comparing the effects of the changes. If the dependent quantity does not change at all, the relationship is referred to as being **constant**. If the dependent quantity increases as the independent quantity increases, the relationship is referred to as being **direct**. If the dependent quantity decreases as the independent quantity increases, the relationship is referred to as being **inverse**.

In his treatise, *Principia*, outlining much of what we now call **classical mechanics**, Sir Isaac Newton presented, more comprehensively, these rules of reasoning, which we can keep in the back of our minds as we proceed to study physics:

1. We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.
2. Therefore, to the same natural effects, we will assign the same natural causes.
3. The qualities of bodies, which do not increase or decrease in amount, and are found to belong to all bodies, as far as we can determine from our experimental instruments, will be called **universal qualities** of all bodies.
4. In experimental science, we look at conclusions inferred by general induction from phenomena as being accurate and very nearly true, notwithstanding any contrary hypotheses we may consider, unless some new phenomenon occurs that causes us to modify these conclusions.

Establishing Relationships in Physics 建立物理学中的关系

Relationships are based on quantitative comparisons using the rules of reasoning described above. To begin with, we ascribe to quantities of matter fundamental characteristics that can be used to distinguish them. Among these are mass, length, and electric current. Since the universe is in constant change, we add time to this list. These characteristics are called **fundamental**.

Quantitative comparisons are based on assigning a magnitude and a scale to each of these quantities. The magnitude indicates the relative size of the quantity, and the scale provides the rule for measurement. Another term we could use instead of "scale" is "unit" or "dimension." Specifically, the units assigned to mass, length, and time (and several others) are called **fundamental units**. In physics, we use the International System of Units (or *Système International d'Unites*, abbreviated SI). Some of the more common units are presented in Appendix E. The concept of measurement and significant figures is covered in Appendix A.

What Is Advanced Placement Physics? 什么是AP物理学?

Advanced Placement Physics is a course designed by the Educational Testing Service (ETS) in Princeton, New Jersey. It is designed to introduce college-level physics to high school students. There are two such courses in use in the United States and North America today. The first course is the subject of this review book and is called Physics B. In this course, you are given a survey of college-level physics without the use of calculus. The second course offered is called Physics C and makes extensive use of calculus.

This review book is designed to prepare you for the Advanced Placement examination covering Physics B. All the major areas covered on the examination are included. There are three full-length simulated examinations, as well as hundreds of other problems for you to work on. Full solutions and explanations are also included.

When using this book, try to solve the problems on your own first and then refer to the solution. You may want to try the diagnostic examination first if you are using the book as simply a review book before the exam. If you are using the book throughout the year as a workbook (or textbook), save the three practice exams for the end of your course.

The Advanced Placement Physics B examinations consists of two sections. Section I contains 70 multiple-choice questions covering all areas of physics. On the actual exam, you will have 1½ hours to complete this part without the use of formula tables or calculators. Section II of the exam consists of between six and eight free-response problems. These might include calculations, graphing, explanations about laboratory situations, short-answer questions, or construction of diagrams. Each part is worth 50 percent of your final grade, which is reported on a scale of 1 through 5 (with a 5 being the highest possible score).

TO THE TEACHER 给教师的建议

Reviewing means much more than going over course material or doing extra problems. Reviewing means developing a systematic approach to studying, understanding, and applying the course material. This includes identifying key concepts, looking for crosslinks and associations from the various subdivisions of physics, developing a scheme for organizing the acquired knowledge, and enhancing problem-solving skills.

From this list of items, problem solving occupies a major goal of this review book. Students learn by doing problems. In the **constructivist** view of learning, a student brings to a physics problem a large amount of prior knowledge based on life experience and past courses.

When new knowledge is acquired, the student actively constructs meaning for that knowledge based on processes that analyze, synthesize, and otherwise associate that knowledge with the student's prior knowledge. Learning is an active as opposed to a passive process. Problem solving is a learning process also.

It has been well documented that beginning physics students often find physics difficult. One of the reasons for this is the way in which physics deals with everyday experiences in an abstract way. Life experiences have given the student an intuitive idea about how the universe works and how to make inferences or draw conclusions. These concepts are often based directly on what the senses detect. As such, students often arrive in a physics class for the first time with misconceptions about the nature of physical knowledge that are counterintuitive to what they are exposed to in the course. Additionally, beginning students have difficulty solving problems that are not simply "plug-and-chug," meaning the direct substitution of numerical values into an algorithmic formula (usually an algebraic equation). Thus, students are often faced with a new way of thinking and looking at the world around them.

A major goal of this book is to enhance the problem-solving and study skills of the student. Therefore, the book will present ideas throughout the review that provide learning, problem-solving, and test-taking strategies.

Contents 目录

Answer Sheet
答题表格
DIAGNOSTIC TEST
摸底考试

1 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	25 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	49 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
2 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	26 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	50 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
3 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	27 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	51 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
4 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	28 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	52 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
5 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	29 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	53 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
6 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	30 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	54 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
7 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	31 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	55 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
8 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	32 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	56 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
9 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	33 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	57 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
10 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	34 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	58 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
11 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	35 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	59 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
12 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	36 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	60 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
13 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	37 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	61 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
14 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	38 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	62 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
15 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	39 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	63 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
16 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	40 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	64 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
17 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	41 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	65 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
18 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	42 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	66 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
19 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	43 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	67 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
20 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	44 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	68 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
21 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	45 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	69 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
22 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	46 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	70 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
23 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	47 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	
24 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	48 Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	

Diagnostic Test 摸底考试

The purpose of a diagnostic examination is to assess your beginning level of understanding before reviewing the topical material. Since ETS prohibits use of its examinations in review books, practice examinations are necessarily simulated. In some cases, the questions may be slightly more difficult or easier than those on an actual exam. Additionally, since the awarding of points for Section II—Free Response varies from year to year, as do the cutoffs for the various AP grades, it is difficult to predict what your grade on the actual exam would be from your performance on a practice test. However, as the saying goes, "Practice makes perfect," and taking the practice examinations will almost certainly improve your performance on the actual examination. After taking the Diagnostic Test, go over the solutions and explanations that follow and then plan your further studies accordingly, using the self-assessment guide.

Chapters 1, 2, and 3 present an introduction to concept identification and problem-solving skills that are integral parts of any successful learning experience. Topical review of material from the AP Physics B curriculum begins with Chapter 4 and continues through Chapter 24. Following the topical review chapters are two more practice examinations, also with fully explained solutions, a glossary, and a mathematical appendix. A cumulative index of material appears at the end of the book. Note: Vectors are represented in boldface type. Constants and formulas are for Section II only!

Good luck!

Useful Constants

1 atomic mass unit	$1\ \text{u} = 1.66 \times 10^{-27}$ kg
Rest mass of the proton	$m_p = 1.67 \times 10^{-27}$ kg
Rest mass of the neutron	$m_n = 1.67 \times 10^{-27}$ kg
Rest mass of the electron	$m_e = 9.11 \times 10^{-27}$ kg
Magnitude of the electron charge	$e = 1.60 \times 10^{-19}$ C
Avogadro's number	$N_0 = 6.02 \times 10^{23}$ per mol
Universal gas constant	$R = 8.32$ J/(mol · K)
Boltzmann's constant	$k_B = 1.38 \times 10^{-23}$ J/K
Speed of light	$c = 3 \times 10^8$ m/s
Planck's constant	$h = 6.63 \times 10^{-34}$ J · s $= 4.14 \times 10^{-15}$ eV · s
1 electron volt	$1\ \text{eV} = 1.6 \times 10^{-19}$ J
Vacuum permittivity	$\epsilon_0 = 8.85 \times 10^{-12}$ C²/N · m²
Coulomb's law constant	$k = (1/4)\pi\epsilon_0 = 9 \times 10^9$ N · m²/C²
Vacuum permeability	$\mu_0 = 4\pi \times 10^{-7}$ Wb/(A · m)
Magnetic constant	$k' = k/c^2 = \mu_0/4\pi = 10^{-7}$ Wb/(A · m)
Acceleration due to gravity at Earth's surface	$\mathbf{g} = 9.8$ m/s²
Universal gravitational constant	$G = 6.67 \times 10^{-11}$ m³/(kg · s²)
1 atmosphere pressure	$1\ \text{atm} = 1.0 \times 10^5$ N/m² $= 1.0 \times 10^5$ Pa
1 nanometer	$1\ \text{nm} = 1.0 \times 10^{-9}$ m

For this examination the following conventions hold:

I. All frames of reference are assumed to be inertial unless otherwise indicated.
II. Electrical current will follow the direction of a positive charge (conventional current).
III. For any isolated charge, the potential at infinity is taken to be equal to zero.
IV. The work done on a thermodynamic system is defined as a positive quantity.

Diagnostic Test 摸底考试

Section I 第一部分

MULTIPLE-CHOICE QUESTIONS 选择题

70 QUESTIONS

90 MINUTES

50 PERCENT OF TOTAL GRADE

Directions: For each of the questions or incomplete statements below there are five choices. In each case select the best answer or completion and fill in the corresponding oval on the answer sheet. You may not use a calculator for this part.

1. Which of the following quantities is *not* a vector?

   (A) Momentum
   (B) Displacement
   (C) Acceleration
   (D) Work
   (E) Impulse

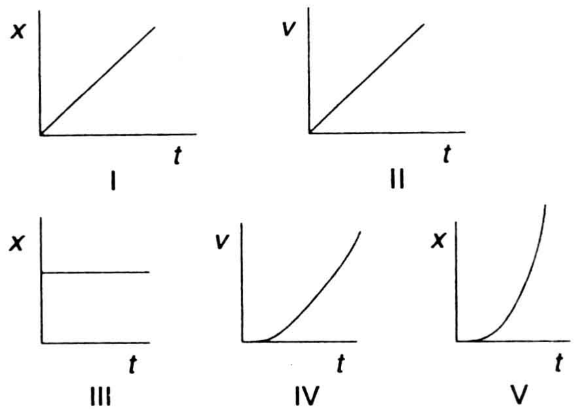
2. A 0.05-kg ball is thrown upward from the ground with an initial velocity of 30 m/s. At its maximum height, the magnitude of the ball's acceleration is approximately

   (A) 0 m/s^2
   (B) 10 m/s^2
   (C) 30 m/s^2
   (D) 45 m/s^2
   (E) Not enough information is given.

3. A projectile is launched at an angle θ to the horizontal with an initial velocity **v**. In the absence of any air resistance, which of the following statements is correct?

   (A) The horizontal velocity increases and then decreases during the flight.
   (B) The horizontal velocity remains constant.
   (C) The vertical velocity remains constant.
   (D) The horizontal velocity decreases and then increases during the flight.
   (E) At the projectile's maximum height, the acceleration vector is zero.

4. Which two graphs represent one-dimensional uniformly accelerated motion?



(A) I and IV
(B) II and III
(C) I and V
(D) IV and V
(E) II and V

5. A rock is thrown horizontally off of the top of a building that is 7.5 m above the ground. It is observed that the rock lands 22 m away from the base of the building. Which of the following would increase the time it takes the rock to reach the ground?

I. Increasing the height
II. Increasing the initial horizontal velocity
III. Increasing the mass of the rock

(A) I only
(B) II only
(C) III only
(D) I and II
(E) II and III

Questions 6 and 7 are based on the following information:

A student swings a 0.035-kg rubber stopper attached to a string in a horizontal circle over her head. The length of the string is 0.6 m. The stopper is observed to complete 10 revolutions in 11.7 s.

6. What is the magnitude of the period of revolution?

(A) 0.85 s
(B) 1.17 s
(C) 3.22 s
(D) 0.65 s
(E) 11.7 s

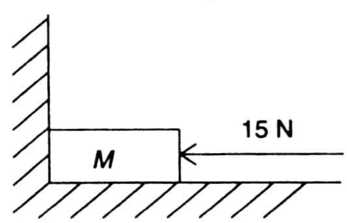
7. Which of the following expressions represents the relationship between the centripetal force **F** acting on the mass and its kinetic energy K?

(A) K/r
(B) $K^2/2r$
(C) $2K/r$
(D) K/r^2
(E) $K/2r$

8. Which of the following statements is correct about a projectile in flight (near Earth)?

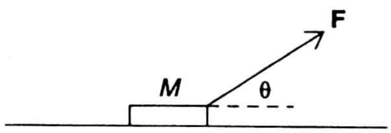
(A) Its acceleration increases during its flight.
(B) Its acceleration decreases during its flight.
(C) Its acceleration decreases, then increases, during its flight.
(D) Its acceleration increases, then decreases, during its flight.
(E) Its acceleration remains constant.

9. A 15-newton force is applied to a mass M that is adjacent to a wall, as shown. If the mass is 2 kilograms, the force that the wall exerts on the mass is equal to



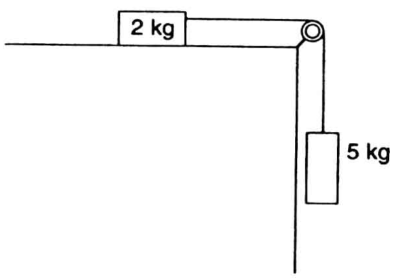
(A) 0 N
(B) 2 N
(C) 15 N
(D) 19.6 N
(E) 30 N

10. In the diagram, a force **F** is applied to a mass *M* at an angle θ to the horizontal. The mass is moving along a flat, smooth horizontal surface. What is the magnitude of the normal force?



(A) $M\mathbf{g} - \mathbf{F} \sin \theta$
(B) $M\mathbf{g} + \mathbf{F} \sin \theta$
(C) $M\mathbf{g}/\mathbf{F} \sin \theta$
(D) $\mathbf{F} \sin \theta / M\mathbf{g}$
(E) $M\mathbf{g}$

11. In the situation shown, a 2-kilogram mass is attached by a light string over a frictionless pulley to a 5-kilogram mass hanging below. The 2-kilogram mass rests on a frictionless surface. If the system is released, what will be the approximate acceleration of both masses?



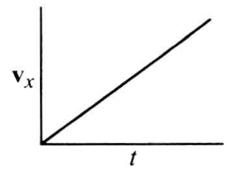
(A) 5 m/s^2
(B) 25 m/s^2
(C) 12 m/s^2
(D) 15 m/s^2
(E) 20 m/s^2

12. A mass *M* rests on top of a frictionless inclined plane. Which of the following statements is correct about the normal force acting on the mass as the angle of elevation increases?

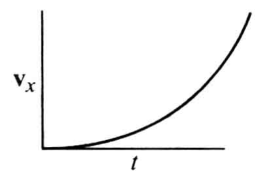
(A) The normal force increases.
(B) The normal force decreases.
(C) The normal force increases, then decreases.
(D) The normal force decreases, then increases.
(E) The normal force remains constant.

13. A projectile is launched with a velocity **v** and angle θ from level ground. If air resistance is neglected, which of the following graphs corresponds to the relationship between the horizontal component of the velocity and time?

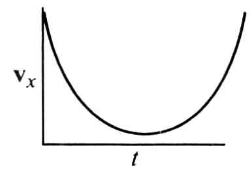
(A)



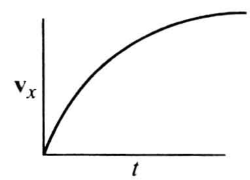
(B)



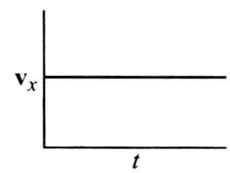
(C)



(D)



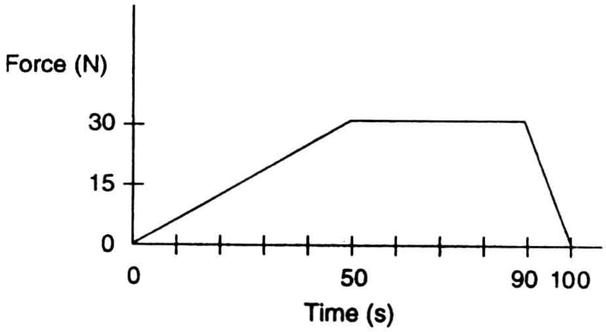
(E)



14. A crate weighing 15 N is moving along a rough horizontal surface with a constant velocity **v**. The coefficient of kinetic friction between the crate and the surface is 0.50. What is the approximate magnitude of the force maintaining the constant velocity?

(A) 0 N
(B) 15 N
(C) 75 N
(D) 30 N
(E) 7.5 N

Questions 15–17 are based on the graph of force versus time shown below for a 15-kilogram mass.



15. What was the total impulse applied to the mass for the entire 100-second interval?

(A) 1750 N · s
(B) 1800 N · s
(C) 1900 N · s
(D) 2100 N · s
(E) 2500 N · s

16. What was the average force applied to the mass during the first 50 seconds?

(A) 7 N
(B) 15 N
(C) 18 N
(D) 21 N
(E) 30 N

17. If the mass had an initial velocity of 4 meters per second, what was its velocity at the end of 50 seconds?

(A) 46 m/s
(B) 50 m/s
(C) 54 m/s
(D) 60 m/s
(E) 66 m/s

18. A 10-kg object has a velocity of 2 m/s to the right. The object is struck by a 0.05-kg wad of putty moving to the left at 10 m/s. The putty sticks to the object after the collision. Which of the following statements is correct?

(A) Linear momentum is not conserved, but kinetic energy is conserved.
(B) Both linear momentum and kinetic energy are conserved.
(C) Linear momentum is conserved, but kinetic energy is not conserved.
(D) Neither linear momentum nor kinetic energy is conserved.
(E) None of the above statements is correct.

19. A mass m is moving with a velocity $\mathbf{v}$. It collides with and sticks to a stationary mass M. Which of the following expressions represents the ratio of the initial kinetic energy to the final kinetic energy?

(A) m/M
(B) $(m + M)/m$
(C) $m + M$
(D) $m - M$
(E) $(m + M)/(m - M)$

20. A 5-kg mass is dropped from a height of 15 m. What will the approximate velocity of the mass be when it is 10 m above the ground?

(A) 0 m/s
(B) 10 m/s
(C) 20 m/s
(D) 50 m/s
(E) 100 m/s

21. A pulley is used to lift a 10-kilogram mass to a height of 2 meters. If 150 newtons of effort was used, the work done to overcome friction was equal to

(A) 14 J
(B) 52 J
(C) 104 J
(D) 196 J
(E) 300 J