

College Physics | Table of Contents

Chapter 1: Introduction: The Nature of Science and Physics

1.1 Physics: An Introduction

- Define physics and identify some of its applications
- Identify aspects of the scientific method
- Distinguish between classical and modern physics

1.2 Physical Quantities and Units

- Identify physical quantities and units of measurement
- Analyze the dimensions of an expression
- Use metric prefixes to express quantities of length, mass, and time
- Convert a quantity from one set of units to another

1.3 Accuracy, Precision, and Significant Figures

- Distinguish between accuracy and precision
- Determine the percent uncertainty of a calculated quantity
- Identify the number of significant digits in a number
- Express the result of a calculation to the correct number of significant digits

1.4 Approximation

- Utilize approximation techniques in calculations

Chapter 2: Kinematics

2.1 Displacement

- Define and distinguish between position, displacement, and distance traveled
- Calculate position, displacement, and distance traveled

2.2 Vectors, Scalars, and Coordinate Systems

- Define and distinguish between vectors and scalars

2.3 Time, Velocity, and Speed

- Define and distinguish between average speed and average velocity
- Define and distinguish between average and instantaneous velocity and speed
- Calculate average velocity, average speed, and time

2.4 Acceleration

- Describe acceleration
- Identify the direction of acceleration
- Calculate acceleration, change in velocity, and time

2.5 Motion Equations for Constant Acceleration in One Dimension

- Identify the equations of one-dimensional kinematics for constant acceleration
- Solve problems dealing with the equations of one-dimensional kinematics
- Solve one-dimensional kinematics problems dealing with one object that experiences two or more different constant accelerations

2.6 Problem-Solving Basics for One-Dimensional Kinematics

- Choose a coordinate system for a one-dimensional kinematics problem
 - Identify the knowns and unknowns in a one-dimensional kinematics problem
 - Choose the correct equation to solve a one-dimensional kinematics problem
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2.7 Falling Objects

- Identify free-fall problems
- Apply the equations of one-dimensional kinematics to freely-falling objects
- Solve additional problems in one-dimensional kinematics

2.8 Graphical Analysis of One-Dimensional Motion

- Calculate the slope of a straight-line graph
- Describe the utility of graphs in one-dimensional kinematics
- Calculate velocity from a position versus time graph
- Calculate acceleration from a velocity versus time graph

Chapter 3: Two-Dimensional Kinematics

3.1 Kinematics in Two Dimensions: An Introduction

- Describe motion in two dimensions
- Calculate the magnitude of a displacement vector

3.2 Vector Addition and Subtraction: Graphical Methods

- Define two-dimensional vectors
- Use the head-to-tail method to add vectors graphically
- Use the head-to-tail method to subtract vectors graphically

3.3 Vector Addition and Subtraction: Analytical Methods

- Identify a vector by its components or its magnitude and direction
- Determine the magnitude of a vector
- Determine the direction of a vector
- Determine the components of a vector
- Add and subtract vectors using analytical methods

3.4 Projectile Motion

- Define projectile motion
- Identify symmetries and implicit data in projectile motion
- Solve horizontal launch problems in projectile motion
- Solve general launch angle problems in projectile motion
- Solve additional problems in projectile motion

3.5 Addition of Velocities

- Describe relative velocity
- Solve problems dealing with relative velocity

Chapter 4: Dynamics: Force and Newton's Laws of Motion

4.1 Development of Force Concept

- Define force
- Define free-body diagram

4.2 Newton's First Law of Motion: Inertia

- Define Newton's first law
 - Apply Newton's first law
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4.3 Newton's Second Law of Motion: Concept of a System

- Define Newton's second law
- Define the base SI units of force
- Define and calculate weight
- Define free fall
- Make a free-body diagram for a system of interest
- Use Newton's second law to calculate net force, mass, and acceleration

4.4 Newton's Third Law of Motion: Symmetry in Forces

- Define Newton's third law
- Identify pairs of forces that are equal and opposite due to Newton's third law
- Identify the correct system in a multi-system scenario

4.5 Normal, Tension, and Other Examples of Forces

- Identify normal forces and their directions
- Identify tension forces and their directions
- Identify frictional forces and their directions
- Identify the x and y components of forces and their directions
- Identify the direction of forces and their components for an object on an inclined plane

4.6 Problem-Solving Strategies

- Make a free-body diagram of an object for which all forces are parallel to the coordinate axes
- Make a free-body diagram of an object for which at least one force has non-zero x and y components
- Make a free-body diagram of an object on an incline
- Write the net force equations for an object for which all forces are parallel to the coordinate axes
- Write the net force equations for an object for which at least one force has non-zero x and y components
- Write the net force equations for an object on an incline

4.7 Further Applications of Newton's Laws of Motion

- Apply Newton's laws to objects for which all forces are parallel to the coordinate axes
- Apply Newton's laws to objects for which at least one force has non-zero x and y components
- Apply Newton's laws to objects on an incline
- Apply Newton's laws to connected objects
- Solve problems that deal with both Newton's laws and kinematics
- Apply Newton's laws to additional applications

4.8 Extended Topic: The Four Basic Forces—An Introduction

- Identify the four basic forces and their properties

Chapter 5: Further Applications of Newton's Laws: Friction, Drag, and Elasticity

5.1 Friction

- Describe kinetic friction and identify the direction of kinetic frictional forces
 - Describe static friction and identify the direction of static frictional forces
 - Describe the relationship between frictional force, the coefficient of friction, and the normal force
 - Solve problems dealing with objects experiencing frictional forces
 - Solve problems dealing with objects on an incline experiencing frictional forces
 - Solve additional problems dealing with frictional forces
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5.2 Drag Forces

- Describe the general characteristics of drag forces and the equations that describe them
- Solve problems using the drag force equation
- Solve problems using Stokes' law

5.3 Elasticity: Stress and Strain

- Describe the relationship between tension, compression, and changes in length (Young's modulus)
- Describe the relationship between shear forces and shear deformation (shear modulus)
- Describe the relationship between pressure change and volume change (bulk modulus)
- Solve problems dealing with elasticity

Chapter 6: Uniform Circular Motion and Gravitation

6.1 Rotation Angle and Angular Velocity

- Convert a rotation angle from one set of units to another
- Describe the relationship between rotation angle, radius, and arc length
- Describe the relationship between angular velocity and linear velocity
- Solve problems dealing with angular velocity and linear velocity

6.2 Centripetal Acceleration

- Define centripetal acceleration
- Identify the direction of centripetal acceleration
- Solve problems dealing with centripetal acceleration

6.3 Centripetal Force

- Define centripetal force
- Write expressions for centripetal force
- Solve problems dealing with centripetal force

6.4 Fictitious Forces and Non-inertial Frames: The Coriolis Force

- Identify fictitious forces and the corresponding real forces
- Describe the Coriolis effect

6.5 Newton's Universal Law of Gravitation

- Describe Newton's universal law of gravitation
- Apply Newton's universal law of gravitation to two bodies
- Apply Newton's universal law of gravitation to three bodies
- Calculate the acceleration of gravity at the surface of planets and stars

6.6 Satellites and Kepler's Laws: An Argument for Simplicity

- Define Kepler's laws
- Apply Kepler's laws

Chapter 7: Work, Energy, and Energy Resources

7.1 Work: The Scientific Definition

- Define work and the equation for the work done by a constant force
 - Determine the angle between a force and a displacement, and the sign of the work done
 - Calculate the work done by a constant force
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7.2 Kinetic Energy and the Work-Energy Theorem

- Describe kinetic energy
- Describe the work-energy theorem
- Apply the work-energy theorem
- Solve additional applications of the work-energy theorem

7.3 Gravitational Potential Energy

- Describe gravitational potential energy
- Identify energy transfers between kinetic energy and gravitational potential energy
- Solve problems dealing with energy transfers between kinetic energy and gravitational potential energy

7.4 Conservative Forces and Potential Energy

- Apply energy conservation to problems dealing with springs
- Identify conservative forces and their characteristics
- Describe potential energy stored in a spring
- Describe the principle of conservation of mechanical energy

7.5 Nonconservative Forces

- Identify nonconservative forces and their characteristics
- Describe the relationship between work done by nonconservative forces and changes in mechanical energy
- Solve problems in which work is done by nonconservative forces

7.6 Conservation of Energy

- Describe the law of conservation of energy

7.7 Power

- Describe Power
- Solve Problems dealing with power, work, and energy

7.8 Work Energy, and Power in Humans

- Describe energy transformations in humans

7.9 World Energy Use

- Describe world energy use

Chapter 8: Linear Momentum and Collisions

8.1 Linear Momentum and Force

- Define linear momentum
- Calculate total linear momentum and changes in linear momentum
- Describe the relationship between momentum and Newton's second law
- Solve problems dealing with the relationship between momentum and force

8.2 Impulse

- Define Impulse

8.3 Conservation of Momentum

- Describe the principle of conservation of linear momentum
 - Analyze concepts dealing with momentum conservation
 - Apply the principle of conservation of linear momentum
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8.4 Elastic Collisions in One Dimension

- Define elastic collision
- Solve problems dealing with elastic collisions

8.5 Inelastic Collisions in One Dimension

- Define inelastic and perfectly inelastic collisions
- Solve problems dealing with inelastic and perfectly inelastic collisions

8.6 Collisions of Point Masses in Two Dimensions

- Define collisions in two dimensions
- Solve problems dealing with collisions in two dimensions

8.7 Introduction to Rocket Propulsion

- Identify the meaning of the equations that describe rocket propulsion
- Solve problems dealing with rocket propulsion

Chapter 9: Statics and Torque

9.1 Linear Momentum and Force

- Define and identify equilibrium

9.2 The Second Condition for Equilibrium

- Calculate torque
- Write expressions for torque
- Distinguish between positive, negative, and zero torque
- Identify points of application for torques due to weight
- Identify the angle to be used in the equation for torque
- Distinguish between lever arm and the distance from the axis to point of application
- Identify the elements that quantify torque
- Distinguish between clockwise and counterclockwise torque
- Identify the elements that determine torque

9.3 Stability

- Evaluate the stability of an object

9.4 Applications of Statics, Including Problem-Solving Strategies

- Solve problems dealing with torque and static equilibrium
- Write expressions for the net torque on an object in static equilibrium
- Make a free-body diagram of an object in static equilibrium

9.5 Simple Machines

- Solve problems dealing with simple machines
- Identify the mechanical advantage afforded by simple machines

9.6 Forces and Torques in Muscles and Joints

- Solve problems dealing with forces and torques in muscles and joints
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Chapter 10: Rotational Motion and Angular Momentum

10.1 Angular Acceleration

- Solve problems dealing with angular and tangential acceleration
- Identify the direction of tangential acceleration and centripetal acceleration
- Calculate angular acceleration, change in angular velocity, and time
- Define angular acceleration

10.2 Kinematics of Rotational Motion

- Solve rotational kinematics problems
- Identify the appropriate rotational units for use in calculations
- Identify the equations of rotational kinematics

10.3 Dynamics of Rotational Motion: Rotational Inertia

- Identify the units of moment of inertia
- Write expressions for the moment of inertia of point masses
- Write expressions for moment of inertia that account for distributed masses
- Solve problems dealing with moment of inertia
- Identify the relationship between net torque, angular acceleration, and moment of inertia
- Solve problems dealing with net torque, angular acceleration, and moment of inertia

10.4 Rotational Kinetic Energy: Work and Energy Revisited

- Solve conservation of energy problems that include rotational kinetic energy
- Solve problems dealing with rotational kinetic energy
- Define rotational kinetic energy
- Solve problems dealing with work, rotation, and torque
- Identify the relationship between work, rotation, and torque

10.5 Angular Momentum and Its Conservation

- Solve problems dealing with angular momentum conservation
- Solve problems dealing with angular momentum
- Define and distinguish angular momentum and linear momentum

10.6 Collisions of Extended Bodies in Two Dimensions

- Solve problems dealing with collisions of extended bodies

10.7 Gyroscopic Effects: Vector Aspects of Angular Momentum

- Identify the vector nature of rotational quantities

Chapter 11: Fluid States

11.1 What Is a Fluid?

- Identify the common phases of matter and their characteristics

11.2 Density

- Define density and identify its SI units
- Solve problems dealing with density, mass, and volume

11.3 Pressure

- Solve problems dealing with pressure, force, and area
 - Describe the direction of force due to a pressure
 - Define pressure and its SI units
-

11.4 Variation of Pressure with Depth in a Fluid

- Describe the relationship between pressure and depth in a fluid
- Solve problems dealing with pressure and depth in a fluid

11.5 Pascal's Principle

- Apply Pascal's principle
- Describe Pascal's principle

11.6 Gauge Pressure, Absolute Pressure, and Pressure Measurement

- Distinguish between absolute pressure and gauge pressure

11.7 Archimedes' Principle

- Apply Archimedes' principle
- Describe Archimedes' principle

11.8 Cohesion and Adhesion in Liquids: Surface Tension and Capillary Action

- Describe surface tension and capillary action

11.9 Pressures in the Body

- Describe pressures in the body

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12.1 Flow Rate and Its Relation to Velocity

- Apply the continuity equation
- Solve problems dealing with flow rate
- Identify concepts surrounding the continuity equation
- Identify the characteristics of fluid flow

12.2 Bernoulli's Equation

- Apply Bernoulli's equation to horizontal flow
- Identify concepts surrounding Bernoulli's equation

12.3 The Most General Applications of Bernoulli's Equation

- Apply Bernoulli's equation

12.4 Viscosity and Laminar Flow; Poiseuille's Law

- Apply Poiseuille's law
- Describe viscosity and Poiseuille's law

12.5 The Onset of Turbulence

- Identify concepts surrounding turbulence

12.6 Motion of an Object in a Viscous Fluid

- Identify concepts surrounding motion of objects in viscous fluids

12.7 Molecular Transport Phenomena: Diffusion, Osmosis, and Related Processes

- Define and distinguish between osmosis and diffusion
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13.1 Temperature

- Define thermal equilibrium and the Zeroth Law of Thermodynamics
- Convert a temperature from one scale to another
- Describe the concept of temperature

13.2 Thermal Expansion of Solids and Liquids

- Solve problems dealing with volume thermal expansion
- Solve problems dealing with linear thermal expansion
- Identify the concepts and equations surrounding thermal expansion

13.3 The Ideal Gas Law

- Solve problems dealing with the ideal gas law
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13.4 Kinetic Theory: Atomic and Molecular Explanation of Pressure and Temperature

- Describe the distribution of molecular speeds in a gas
- Solve problems dealing with the relationship between root-mean-square speed and temperature
- Identify the concepts surrounding root mean square speed and the "kinetic theory" equation

13.5 Phase Changes

- Describe the features of a phase diagram
- Identify the critical point and other features of a PV diagram

13.6 Humidity, Evaporation, and Boiling

- Calculate vapor pressure, relative humidity, and dew point
- Describe humidity, evaporation, and boiling

Chapter 14: Heat and Heat Transfer Methods

14.1 Heat

- Define heat as a transfer of energy

14.2 Temperature Change and Heat Capacity

- Solve calorimetry problems in which there are no phase changes
- Identify the concepts and equations surrounding calorimetry problems (no phase changes)
- Solve problems dealing with the relationship between temperature change and heat
- Describe the relationship between temperature change and heat

14.3 Phase Change and Latent Heat

- Solve calorimetry problems in which there is a phase change
- Identify the concepts and equations surrounding calorimetry problems (includes phase changes)
- Solve problems dealing with phase changes and latent heat
- Describe the relationship between heat and latent heat for a phase change

14.4 Heat Transfer Methods

- Distinguish between heat conduction, convection, and radiation

14.5 Conduction

- Solve problems dealing with the conduction of heat
- Describe the conduction of heat and the equation that describes it

14.6 Convection

- Identify the concepts surrounding the convection of heat
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14.7 Radiation

- Solve problems dealing with the radiation of heat
- Describe radiation of heat and the equation that describes it

Chapter Chapter 15: Thermodynamics

15.1 The First Law of Thermodynamics

- Solve problems dealing with the first law of thermodynamics
- Describe the first law of thermodynamics

15.2 The First Law of Thermodynamics and Some Simple Processes

- Identify reversible and irreversible processes and the second law of thermodynamics
- Calculate work as the area under a PV curve
- Distinguish between isochoric, isobaric, isothermal, and adiabatic processes and their PV diagrams
- Describe thermodynamic work and PV diagrams

15.3 Introduction to the Second Law of Thermodynamics: Heat Engines and Their Efficiency

- Solve simple problems dealing with heat engines
- Describe a heat engine and the related quantities

15.4 Carnot's Perfect Heat Engine: The Second Law of Thermodynamics Restated

- Identify the processes in a Carnot cycle
- Solve problems dealing with the Carnot heat engine

15.5 Applications of Thermodynamics: Heat Pumps and Refrigerators

- Solve problems dealing with heat pumps and refrigerators
- Describe heat pumps, refrigerators, and the concepts and quantities surrounding them

15.6 Entropy and the Second Law of Thermodynamics: Disorder and the Unavailability of Energy

- Describe entropy in the context of the second law of thermodynamics
- Solve problems dealing with entropy and the unavailability of work
- Solve problems dealing with changes in entropy arising from heat transfer between reservoirs
- Define change in entropy

15.7 Statistical Interpretation of Entropy and the Second Law of Thermodynamics: The Underlying Explanation

- Describe the statistical interpretation of entropy

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16.1 Hooke's Law: Stress and Strain Revisited

- Describe elastic potential energy of restoring forces
- Solve problems dealing with Hooke's law
- Describe restoring forces that obey Hooke's law

16.2 Period and Frequency in Oscillations

- Solve problems dealing with period and frequency
- Define and distinguish between period and frequency

16.3 Simple Harmonic Motion: A Special Periodic Motion

- Solve problems dealing with position, velocity, and acceleration in simple harmonic motion
 - Identify the concepts surrounding position, velocity, and acceleration in simple harmonic motion
 - Solve problems dealing with the period and frequency of a mass on a spring
 - Define simple harmonic motion
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16.4 The Simple Pendulum

- Solve problems dealing with the simple pendulum
- Identify the conceptual basis of the simple pendulum

16.5 Energy and the Simple Harmonic Oscillator

- Solve problems dealing with energy in simple harmonic motion
- Identify energy and energy transformations in simple harmonic motion

16.6 Uniform Circular Motion and Simple Harmonic Motion

- Identify the connections between circular motion and simple harmonic motion

16.7 Damped Harmonic Motion

- Identify elements of damped harmonic motion

16.8 Forced Oscillations and Resonance

- Identify the elements of forced oscillations and resonance

16.9 Waves

- Solve problems dealing with the relationship between speed, wavelength, and frequency
- Identify the terminology used to describe periodic waves
- Define wave and distinguish between longitudinal and transverse waves

16.10 Superposition and Interference

- Solve problems dealing with beats
- Define beats and beat frequency
- Solve problems dealing with standing waves on a string
- Define standing waves and identify the associated terminology
- Define wave interference and distinguish between constructive and destructive interference

16.11 Energy in Waves: Intensity

- Solve problems dealing with wave intensity
- Define wave intensity

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17.1 Physics of Hearing

- Identify the terminology of sound waves

17.2 Speed of Sound, Frequency, and Wavelength

- Solve problems dealing with the relationship between wavelength, frequency, period and speed
- Discuss pitch, frequency, wavelength, and speed of sound waves

17.3 Sound Intensity and Sound Level

- Solve problems dealing with intensity and intensity level
- Identify the relationships between intensity and intensity level

17.4 Doppler Effect and Sonic Booms

- Solve Doppler effect problems with both source and observer moving
 - Solve problems dealing with the Doppler effect
 - Choose the plus and minus signs in the Doppler effect equations
 - Identify the concepts surrounding the Doppler effect
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17.5 Sound Interference and Resonance: Standing Waves in Air Columns

- Solve problems dealing with standing sound waves in air columns
- Identify the concepts surrounding standing waves in air columns

17.6 Hearing

- Identify elements of human hearing

17.7 Ultrasound

- Describe the concepts and applications of ultrasound
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