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Introduction: Forces in Multiple Dimensions

Unit: Forces in Multiple Dimensions

Topics covered in this chapter:

In this chapter you will learn about different kinds of forces and how they relate.

- *Force Applied at an Angle*, *Ramp Problems*, and *Pulleys & Tension* describe some common situations involving forces and how to calculate the forces involved.
- *Centripetal Force* describes the forces experienced by an object moving in a circle.
- *Center of Mass, Rotational Inertia,* and *Torque* describe the relationship between forces and rotation.

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This unit is part of *Unit 2: Force and Translational Dynamics* from the 2024 AP® Physics 1 Course and Exam Description.

Standards addressed in this chapter:

NGSS Standards/MA Curriculum Frameworks (2016):

HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

HS-PS2-10(MA). Use free-body force diagrams, algebraic expressions, and Newton's laws of motion to predict changes to velocity and acceleration for an object moving in one dimension in various situations.

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AP® Physics 1 Learning Objectives/Essential Knowledge (2024):

2.2.A: Describe a force as an interaction between two objects or systems.

2.2.A.1: Forces are vector quantities that describe the interactions between objects or systems.

2.2.A.1.i: A force exerted on an object or system is always due to the interaction of that object with another object or system.

2.2.A.1.ii: An object or system cannot exert a net force on itself.

2.2.A.2: Contact forces describe the interaction of

an object or system touching another object or system and are macroscopic effects of interatomic electric forces.

2.2.B: Describe the forces exerted on an object or system using a free-body diagram.

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2.2.B.1: Free-body diagrams are useful tools for visualizing forces being exerted on a single object or system and for determining the equations that represent a physical situation.

2.2.B.2: The free-body diagram of an object or system shows each of the forces exerted on the object by the environment.

2.2.B.3: Forces exerted on an object or system are represented as vectors originating from the representation of the center of mass, such as a dot. A system is treated as though all of its mass is located at the center of mass.

2.2.B.4: A coordinate system with one axis parallel to the direction of acceleration of the object or system simplifies the translation from free-body diagram to algebraic representation. For example, in a free-body diagram of an object on an inclined plane, it is useful to set one axis parallel to the surface of the incline.

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Skills learned & applied in this chapter:

- Solving chains of equations.
- Using geometry and trigonometry to combine forces (vectors).
- Using trigonometry to split forces (vectors) into components.

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