Force and Motion

Course 391: Force and Motion

Covers fundamentals of force and motion, showing how an engineer thinks about these concepts. Demonstrates how mathematical and graphical representations can help clarify our thinking about mechanical force and motion.

TPC Training is accredited by IACET to offer **0.8 CEU** for this program.

Lesson 1: Scalars and Vectors

Topics

Introduction to Physical Quantities; Locating Points on a Map; Vectoring a Trip on the Map; Properties of Vectors; Components of Vectors; Vector Sum; A Rule for Adding Vectors; Subtraction of Vectors; Vector Multiplication and Division

Objectives

- Explain the difference between scalars and vectors, and list examples of each.
- Draw a vector, given a verbal description.
- Describe a vector verbally, given its graphic symbol, a frame of reference, and an appropriate scale.
- Define resolution, resultant, and commutative.
- Demonstrate how to resolve a vector into its rectangular components.
- Demonstrate how to add and subtract vector quantities in one-dimensional and two-dimensional frames of reference.
- Multiply and divide a vector by a scalar.

Lesson 2: Motion Along a Straight Line

Topics

Speed; Velocity; Velocity and Slope; The Difference Between Speed and Velocity; Changing Velocity; Instantaneous Velocity; Constructing a Velocity-Versus-Time Graph; Finding Displacement; Using a Curved Graph

Objectives

- Explain the difference between speed and velocity.
- Define the terms instantaneous velocity, average velocity, and slope.
- Identify the delta notation, and explain how to use it in a calculation.
- Demonstrate how to determine displacement and velocity from a position-versus-time graph.
- Demonstrate how to determine displacement by calculating the area under a velocity-versus-time graph.

Lesson 3: Acceleration

Topics

Introduction to Acceleration; Directional Acceleration; Equations of Motion; Acceleration Due to Gravity; Upward and Lateral Motion During Free Fall

Objectives

- Define acceleration.
- Demonstrate how to determine the magnitude of an acceleration from a velocity-verses-time graph.
- Demonstrate the difference between average acceleration and instantaneous acceleration.
- Solve simple problems for average acceleration, displacement, and final velocity.
- Explain why the velocity-verses-time graph for all objects in free fall are parallel (when drawn on the same coordinate system).

Lesson 4: How to Describe Force

Topics

The How's and Why's of Motion; Definition of Force; Representation of Force; The Basic Forces of Nature; Action-Reaction Pairs; Newton's Third Law of Motion; Unbalanced Forces; Resolution of Forces

Objectives

- Define force.
- Name the four basic types of forces in nature.
- State Newton's Universal Law of Gravitation.
- Explain how and why vectors are used to represent forces.
- Explain Newton's Third Law of Motion.
- Give examples which demonstrate that forces always occur in action-reaction pairs.
- Demonstrate how to add force vectors.
- Describe how to resolve a force vector into its components.

Lesson 5: Force and Acceleration

Topics

Friction; Newton's First Law of Motion; "Resistance" to Acceleration; Newton's Second Law of Motion; Units of Force; Applications of Newton's Second Law; Conservation of Momentum; The Effect of Weightlessness

Objectives

- State Newton's First Law of Motion.
- Define inertia, and describe how it is measured.
- Explain why a force must be applied continuously to objects on earth in order to maintain their motion.
- Explain what happens when a net applied force is greater than the friction force.
- State Newton's Second Law of Motion.
- Solve problems using the equation F=ma.

Lesson 6: Equilibrium

Topics

Forces on Bodies; Particles in Static Equilibrium; Equilibrium of a Rigid Body; Center of Mass

Objectives

- State the two conditions of equilibrium, and distinguish between static and dynamic equilibrium.
- Explain the difference between particles and rigid bodies.
- Define torque.
- Solve problems involving torque and rotational equilibrium.

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Lesson 7: Rotational and Circular Motion

Topics

Centripetal Force; Rotational Motion; Angular Displacement and Radian Measure; Angular Velocity; Angular Acceleration; Tangential Acceleration; Moments of Inertia; Centrifugal Force; Conservation of Angular Momentum

Objectives

- Describe centripetal force.
- Differentiate between centripetal acceleration, angular acceleration, and tangential acceleration, and state the formula for each.
- Demonstrate how to convert degree measurements to radian measurements.
- Define the terms uniform circular motion, period angular velocity, angular impulse, angular momentum, and moment of inertia.
- Explain why moment of inertia is calculated differently for different objects.
- State Newton's Second Law in terms of rotational motion.
- Identify examples of the Law of Conservation of Angular Momentum.

Lesson 8: Simple Harmonic Motion

Topics

Periodic Motion; Projections of Circular Motion; Terminology of Simple Harmonic Motion; Causes of Harmonic Motion; Hooke's Law; Equations of Harmony; Resonance

Objectives

- Describe the relationship between simple harmonic motion and uniform circular motion.
- Define the terms cycle, amplitude, frequency, period, and Hertz.
- State Hooke's Law.
- Describe how acceleration and restoring force vectors change as an object moves in simple harmonic motion.
- Use equations to determine the period and frequency of both a mass-spring system and a pendulum.
- Give examples of resonance.