

Deep Dive Study Guide Force & Motion

Short-Answer Quiz

Instructions: Answer the following questions in 2-3 complete sentences, drawing upon the concepts and definitions provided in the course materials.

1. What is the fundamental difference between balanced and unbalanced forces, and what effect does each have on an object's motion?
2. Explain why a tennis ball resists a change in motion more effectively than a Ping-Pong ball when the same amount of force is applied to both.
3. According to the Phet Lab Simulation, what is the relationship between an object's motion and its net force?
4. What are the three essential characteristics that define a good reference point for observing motion?
5. How is the concept of velocity distinct from the concept of speed?
6. Describe the three specific ways in which an object's velocity can change, leading to acceleration.
7. What two specific pieces of information does a motion vector convey about an object's movement?
8. In the example of the skydiver, which force remains constant and which force changes during the descent?
9. When are equal and opposite forces able to cancel each other out, and when do they not?
10. Define displacement and explain why it is considered a vector quantity.

Quiz Answer Key

1. Balanced forces are equal and opposite, resulting in no change to an object's speed or motion. Unbalanced forces are unequal in size, causing a change in motion, which is known as acceleration.
2. The tennis ball resists a change in motion more effectively because it has more mass, and therefore more inertia. Objects with greater inertia require a larger force to change their state of motion.

3. When the net force on an object is zero, there will be no change in the object's motion. A change in motion (acceleration) will only occur when the net force is not zero and will continue until the forces become balanced again.
4. A good reference point must be stationary and not in motion itself. It also needs to be easy to locate and unique, or one of a kind.
5. Speed is a rate that describes how fast an object moves over time (distance / time) and is expressed only as a size or amount. Velocity includes this speed but also specifies the direction of the moving object, making it a vector quantity.
6. An object accelerates if its velocity changes in one of three ways: speeding up (accelerating), slowing down (decelerating), or turning and changing direction. A constant speed in a circular path, like on a merry-go-round, is an example of acceleration due to the constant change in direction.
7. A motion vector conveys the magnitude (size) and the direction of motion. The length of the vector's arrow represents the distance traveled (size), while the tip of the arrow indicates the direction of the motion.
8. During the skydiver's descent, the force of gravity remains constant. The upward force of air resistance (a type of friction) is the force that changes throughout the fall.
9. Equal and opposite forces cancel each other out when they are applied to the same object. However, if equal and opposite forces are applied to different objects, they do not cancel each other out.
10. Displacement is the straight linear line connecting a reference point to an object's final endpoint. It is considered a vector because it specifies both a distance (its length) and a direction from the starting point to the end point.

Essay Questions

Instructions: Formulate detailed responses to the following prompts, synthesizing multiple concepts from the unit to build a comprehensive argument.

1. Using the concepts of reference points, frame of reference, position, and vectors, explain how two different observers can accurately describe the same moving object's motion in entirely different ways.

2. An object is moving at a constant speed in a perfect circle, such as a car on a roundabout or a person on a merry-go-round. Is this object accelerating? Justify your answer using the precise definitions of velocity and acceleration.
3. Compare and contrast the concepts of speed, velocity, and acceleration. Discuss how they are related, what conditions cause each to change, and why it is important to distinguish between them when describing motion.
4. Describe the fundamental relationship between mass, inertia, and force. Use the "Newton Knew Mass Matters" activity (flicking a Ping-Pong ball versus a tennis ball) as a core example to illustrate your explanation.
5. Analyze the complete motion of a skydiver from the moment of leaving the plane to landing safely on the ground. Discuss the roles of gravity, air resistance, balanced forces, and unbalanced forces at various stages of the skydive to explain changes in the skydiver's acceleration and velocity.

Glossary of Key Terms

Term	Definition
Acceleration	Any change in velocity, which can occur by speeding up, slowing down, or turning/changing direction. Acceleration only happens when an unbalanced force is applied.
Air Resistance	An upward force of friction that acts on an object moving through the air, such as a skydiver. This force can change.
Balanced Forces	Equal and opposite forces applied to an object that cancel each other out, resulting in no change in the object's motion.
Displacement	A vector quantity representing the straight linear distance and direction from a reference point to an object's final position.
Force	A push or a pull. Forces are described with vector arrows; their direction indicates the direction of the force and their size indicates the strength of the force.
Frame of Reference	The "point of view" from which motion is observed. The same motion can be viewed differently from various frames of reference.

Gravity	A force that stays the same on all objects. In the skydiver example, it is a constant downward force.
Inertia	An object's tendency to keep doing what it is doing (resist a change in motion). Objects with more mass have more inertia.
Mass	A measure of an object's inertia. Objects with greater mass require a greater force to change their motion.
Motion	A change in an object's position over time, as compared to a reference point.
Motion Vector	A quantity that has both magnitude (size) and direction. For motion, the arrow's length represents distance traveled and its tip indicates the direction.
Net Force	The overall force acting on an object. If the net force is zero, motion does not change; if it is not zero, the object accelerates.
Position	An object's location, which is defined relative to a reference point and a set of reference directions. It requires both distance and direction to be specified.
Reference Point	A stationary object that appears to stay in place (e.g., building, tree) and is used to detect or describe motion. A good reference point is stationary, easy to find, and unique.
Speed	The rate at which an object moves over time, calculated as distance divided by time. It is a size or amount only, with no direction specified.
Unbalanced Force	Forces that are unequal in size, resulting in a net force that is not zero and causes a change in an object's motion (acceleration).
Velocity	A vector quantity that describes an object's speed plus its direction of motion. It represents the actual current motion of the object.
Vector	A quantity that has both a magnitude (size) and a direction. Position, displacement, motion, and velocity are all vector quantities.