

NEWTON'S LAWS

Concept Summary

4.1 The Concepts of Force and Mass A force is a push or a pull and is a vector quantity. Contact forces arise from the physical contact between two objects. Noncontact forces are also called action-at-a-distance forces, because they arise without physical contact between two objects.

Mass is a property of matter that determines how difficult it is to accelerate or decelerate an object. Mass is a scalar quantity.

4.2 Newton's First Law of Motion Newton's first law of motion, sometimes called the law of inertia, states that an object continues in a state of rest or in a state of motion at a constant velocity unless compelled to change that state by a net force.

Inertia is the natural tendency of an object to remain at rest or in motion at a constant velocity. The mass of a body is a quantitative measure of inertia and is measured in an SI unit called the kilogram (kg). An inertial reference frame is one in which Newton's law of inertia is valid.

4.3 Newton's Second Law of Motion/4.4 The Vector Nature of Newton's Second Law of Motion Newton's second law of motion states that when a net force $\Sigma \vec{F}$ acts on an object of mass m , the acceleration \vec{a} of the object can be obtained from Equation 4.1. This is a vector equation and, for motion in two dimensions, is equivalent to Equations 4.2a and 4.2b. In these equations the x and y subscripts refer to the scalar components of the force and acceleration vectors. The SI unit of force is the newton (N).

When determining the net force, a free-body diagram is helpful. A free-body diagram is a diagram that represents the object and the forces acting on it.

4.5 Newton's Third Law of Motion Newton's third law of motion, often called the action-reaction law, states that whenever one object exerts a force on a second object, the second object exerts an oppositely directed force of equal magnitude on the first object.

$$\Sigma \vec{F} = m\vec{a} \quad (4.1)$$

$$\Sigma F_x = ma_x \quad (4.2a)$$

$$\Sigma F_y = ma_y \quad (4.2b)$$

ANSWER AND EXPLAIN ^{your Reasoning}

Focus on Concepts

Note to Instructors: The numbering of the questions shown here reflects the fact that they are only a representative subset of the total number that are available online. However, all of the questions are available for assignment via an online homework management program such as WileyPLUS or WebAssign.

Section 4.2 Newton's First Law of Motion

1. An object is moving at a constant velocity. All but one of the following statements could be true. Which one cannot be true? (a) No forces act on the object. (b) A single force acts on the object. (c) Two forces act simultaneously on the object. (d) Three forces act simultaneously on the object.

3. A cup of coffee is sitting on a table in a recreational vehicle (RV). The cup slides toward the rear of the RV. According to Newton's first law, which one or more of the following statements could describe the motion of the RV? (A) The RV is at rest, and the driver suddenly accelerates. (B) The RV is moving forward, and the driver suddenly accelerates. (C) The RV is moving backward, and the driver suddenly hits the brakes. (a) A (b) B (c) C (d) A and B (e) A, B, and C

Section 4.4 The Vector Nature of Newton's Second Law of Motion

5. Two forces act on a moving object that has a mass of 27 kg. One force has a magnitude of 12 N and points due south, while the other force has a magnitude of 17 N and points due west. What is the acceleration of the object? (a) 0.63 m/s² directed 55° south of west (b) 0.44 m/s² directed

24° south of west (c) 0.77 m/s² directed 35° south of west (d) 0.77 m/s² directed 55° south of west (e) 1.1 m/s² directed 35° south of west

Section 4.5 Newton's Third Law of Motion

7. Which one of the following is true, according to Newton's laws of motion? Ignore friction. (a) A sports utility vehicle (SUV) hits a stationary motorcycle. Since it is stationary, the motorcycle sustains a greater force than the SUV does. (b) A semitrailer truck crashes all the way through a wall. Since the wall collapses, the wall sustains a greater force than the truck does. (c) Sam (18 years old) and his sister (9 years old) go ice skating. They push off against each other and fly apart. Sam flies off with the greater acceleration. (d) Two astronauts on a space walk are throwing a ball back and forth between each other. In this game of catch the distance between them remains constant. (e) None of the above is true, according to the third law.

8. Two ice skaters, Paul and Tom, are each holding on to opposite ends of the same rope. Each pulls the other toward him. The magnitude of Paul's acceleration is 1.25 times greater than the magnitude of Tom's acceleration. What is the ratio of Paul's mass to Tom's mass? (a) 0.67 (b) 0.80 (c) 0.25 (d) 1.25 (e) 0.50

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