

Newton’s First Law “The Law Of Inertia”

Key Terms and Matching Definitions

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|------------------------|---|
| _____ equilibrium rule | _____ Newton’s first law of motion—the law of inertia |
| _____ force | _____ speed |
| _____ inertia | _____ support force |
| _____ net force | _____ vector quantity |
| _____ Newton | _____ velocity |



1. The property of things to remain at rest if at rest, and in motion if in motion.
2. The distance traveled per time.
3. The speed of an object and specification of its direction of motion.
4. A quantity that specifies direction as well as magnitude.
5. Every object continues in a state of rest, or in a state of motion in a straight line at constant speed, unless it is compelled to change that state by forces exerted upon it.
6. A push or a pull.
7. The combination of all forces that act on an object.
8. The scientific unit of force.
9. $\Sigma F = 0$.
10. The force that supports an object against gravity.

Review Questions

2.1 Aristotle’s Classification of Motion

1. According to Aristotle, what tendency of moving objects governed their motions?

2. According to Aristotle, what kinds of motion required no forces?

2.2 Galileo’s Concept of Inertia

3. What two main ideas of Aristotle did Galileo discredit?

4. What is the name of the property of objects to maintain their states of motion?

2.3 Galileo Formulated the Concepts of Speed and Velocity

5. Distinguish between speed and velocity.

6. Why do we say velocity is a vector quantity and speed is not?

2.4 Motion is Relative

7. How can you be both at rest and also moving at 100,000 km/h at the same time?
8. Between Aristotle and Galileo, who relied on experiments?

2.5 Newton's First Law of Motion–The Law of Inertia

9. Who was the first to discover the concept of inertia, Galileo or Newton?
10. What is the tendency of a moving object when no forces act on it?

2.6 Net Force–The Combination of All Forces That Act on an Object

11. When only a pair of equal and opposite forces act on an object, what is the net force acting on it?
12. We've learned that velocity is a vector quantity. Is force also a vector quantity? Why or why not?

2.7 Equilibrium for Objects at Rest

13. What is the name given to the force that occurs in a rope when both ends are pulled in opposite directions?
14. How much tension is there in a rope that holds a 20-N bag of apples at rest?
15. What does $\Sigma F = 0$ mean?

2.8 The Support Force–Why We Don't Fall Through the Floor

16. Why is the support force on an object often called the *normal* force?
17. When you weigh yourself, are you actually reading the support force acting on you, or are you really reading your weight?

2.9 Equilibrium for Moving Objects

18. Give an example of something moving when a net force of zero acts on it.
19. If we push a crate at constant velocity, how do we know how much friction acts on the crate compared to our pushing force?

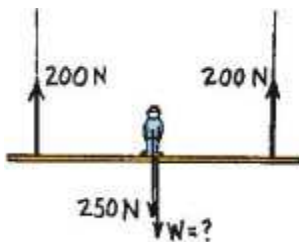
2.10 The Earth Moves Around the Sun

20. If you're in a smooth-riding bus that is going at 50 km/h and you flip a coin vertically, what is the horizontal velocity of the coin in midair?

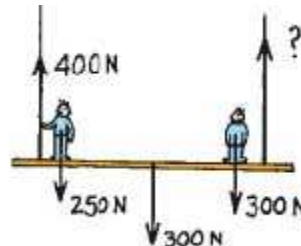
Exercises

- Galileo found that a ball rolling down one incline will pick up enough speed to roll up another. How high will it roll compared to its initial height?
- Correct your friend who says, "The race-car driver rounded the curve at a constant velocity of 100 km/h."
- If a huge bear were chasing you, its enormous mass would be very threatening. But if you ran in a zigzag pattern, the bear's mass would be to your advantage. Why?
- A space probe may be carried by a rocket into outer space. What keeps the probe going after the rocket no longer pushes it?
- Consider a ball at rest in the middle of a toy wagon. When the wagon is pulled forward, the ball rolls against the back of the wagon. Interpret this observation in terms of Newton's first law.
- Why do you lurch forward in a bus that suddenly slows? Why do you lurch backward when it picks up speed? What law applies here?
- Push a shopping cart and it moves. When you stop pushing, it comes to rest. Does this violate Newton's law of inertia? Defend your answer.
- Roll a bowling ball down a lane and you'll find it moves slightly slower with time. Does this violate Newton's law of inertia? Defend your answer.
- Consider a pair of forces, one having a magnitude of 20 N, and the other 12 N. What maximum net force is possible for these two forces? What is the minimum net force possible?

10. The sketch shows a painting staging in equilibrium. The person in the middle weighs 250 N, and the tensions in each rope are 200 N. What is the weight of the staging?



11. A different staging that weighs 300 N supports two painters, one 250 N and the other 300 N. The reading in the left scale is 400 N. What is the reading in the right hand scale?



12. As you stand at rest on a floor, does the floor exert an upward force against your feet? If so, what exactly is this force?
13. A child learns in school that the Earth is traveling faster than 100,000 kilometers per hour around the sun, and in a frightened tone asks why we aren't swept off. What is your explanation?
14. If you toss a coin straight upward while riding in a train, where does the coin land when the motion of the train is uniform along a straight-line track? When the train slows while the coin is in the air? When the train is turning?
15. As the Earth rotates about its axis, it takes 3 hours for the United States to pass beneath a point above the Earth that is stationary relative to the sun. What is wrong with the following scheme? To travel from Washington D.C. to San Francisco and use very little fuel, simply ascend in a helicopter high over Washington D.C. and wait three hours until San Francisco passes below.

Problems

1. What is your average speed if you run 50 meters in 10 seconds?
2. A tennis ball travels the full length of the court, 24 meters, in 0.5 second. What is its average speed?
3. Find the net force produced by a 30-N and 20-N force in each of the following cases:
 - a. Both forces act in the same direction.
 - b. Both forces act in opposite directions.
4. A horizontal force of 100 N pushes a box across a floor at a constant speed.
 - a. What is the net force acting on the box?
 - b. What is the force of friction on the box?
5. Phil Physicer weighs 600 N (132 lb) and stands on two bathroom scales. He stands so one scale reads twice as much as the other. What are the scale readings?