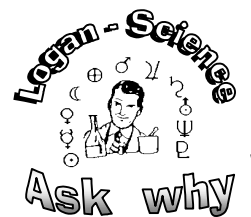


Newton's Second Law of Motion "Force & Acceleration"**Key Terms and Matching Definitions**

_____ acceleration	_____ Newton's second law
_____ air drag	_____ mass
_____ free fall	_____ terminal speed
_____ friction	_____ terminal velocity
_____ inertia	_____ volume
_____ inversely	_____ weight
_____ kilogram	



1. The rate at which velocity changes with time; the change may be in magnitude or direction or both.
2. The property of things to resist changes in motion.
3. The quantity of matter in an object. More specifically, it is the measure of the inertia or sluggishness that an object exhibits in response to any effort made to start it, stop it, deflect it, or change in any way its state of motion.
4. When two values change in opposite directions, so that if one increases and the other decreases by the same amount, they are said to be inversely proportional to each other.
5. The quantity of space an object occupies.
6. The force due to gravity on an object.
7. The fundamental SI unit of mass. One kilogram (symbol kg) is the mass of 1 liter (l) of water at 4°C.
8. The acceleration produced by a net force on an object is directly proportional to the net force, is in the same direction as the net force, and is inversely proportional to the mass of the object.
9. The resistive force that opposes the motion or attempted motion of an object past another with which it is in contact, or through a fluid.
10. Motion under the influence of gravitational pull only.
11. Frictional resistance due to motion through air.
12. The speed at which the acceleration of a falling object terminates because air resistance balances its weight.
13. Terminal speed with direction of motion (down for falling objects).

Review Questions**3.1 Galileo Developed the Concept of Acceleration**

1. Distinguish between velocity and acceleration.
2. When are you most aware of motion in a moving vehicle—when it is moving steadily in a straight line or when it is accelerating?
3. What is the acceleration of free fall?

3.2 Force Causes Acceleration

4. Is acceleration proportional to net force or does acceleration equal net force?

3.3 Mass Is a Measure of Inertia

5. What relationship does mass have with inertia?
6. What relationship does mass have with weight?
7. Fill in the blanks: Shake something to and fro and you're measuring its _____. Lift it against gravity and you're measuring its _____.
8. What is the weight of a 1-kilogram brick?

3.4 Mass Resists Acceleration

9. Is acceleration *directly* proportional to mass, or is it *inversely* proportional to mass? Give an example.

3.5 Newton's Second Law Links Force, Acceleration, and Mass

10. If the net force acting on a sliding block is somehow tripled, by how much does the acceleration increase?
11. If the mass of a sliding block is somehow tripled at the same time the net force on it is tripled, how does the resulting acceleration compare to the original acceleration?

3.6 Friction Is a Force That Affects Motion

12. Suppose you exert a horizontal push on a crate that rests on a level floor, and it doesn't move. How much friction acts compared with your push?
13. As you increase your push, will friction on the crate increase also?
14. Once the crate is sliding, how hard do you push to keep it moving at constant velocity?

3.7 Objects in Free Fall Have Equal Acceleration

15. What is meant by *free fall*?

3.8 Newton's Second Law Explains Why Objects in Free Fall Have Equal Acceleration

16. Why doesn't a heavy object accelerate more than a light object when both are freely falling?
17. The ratio of circumference/diameter for all circles is π . What is the ratio of force/mass for freely-falling bodies?

3.9 Acceleration of Fall Is Less When Air Drag Acts

18. What two principal factors affect the force of air resistance on a falling object?
19. What is the acceleration of a falling object that has reached its terminal velocity?
20. If two objects, the same size fall through air at different speeds, which encounters the greater air resistance?

Exercises

1. What is the net force on a red Mercedes convertible traveling along a straight road at a steady speed of 100 km/h?
2. On a long alley a bowling ball slows down as it rolls. Is any horizontal force acting on the ball? How do you know?
3. In the orbiting space shuttle you are handed two identical boxes, one filled with sand and the other filled with feathers. How can you tell which is which without opening the boxes?
4. Your empty hand is not hurt when it bangs lightly against a wall. Why is it hurt if it does so while carrying a heavy load? Which of Newton's laws is most applicable here?
5. What happens to your weight when your mass increases?
6. When a junked car is crushed into a compact cube, does its mass change? Its weight? Its volume? Explain.
7. What is the net force on a 1-N apple when you hold it at rest above your head? What is the net force on it after you release it?
8. Does a stick of dynamite contain force?
9. If it takes 1 N to push horizontally on your book to make it slide at constant velocity, how much force of friction acts on the book?
10. A bear that weighs 4000 N grasps a vertical tree and slides down at constant velocity. What is the friction force that acts on the bear?
11. A crate remains at rest on a factory floor while you push on it with a horizontal force F . How big is the friction force exerted on the crate by the floor? Explain.
12. Aristotle claimed the speed of a falling object depends on its weight. We now know that objects in free fall, whatever their weights, undergo the same gain in speed. Why does weight not affect acceleration?

13. Two basketballs are dropped from a high building through the air. One ball is hollow and the other filled with rocks. Which accelerates more? Defend your answer.
14. A parachutist, after opening the chute, finds herself gently floating downward, no longer gaining speed. She feels the upward pull of the harness, while gravity pulls her down. Which of these two forces is greater? Or are they equal in magnitude?
15. Why will a sheet of paper fall slower than one that is wadded into a ball?
16. Upon which will air resistance be greater; a sheet of falling paper or the same paper wadded into a ball that falls at a faster terminal speed? (Careful!)
17. How does the force of gravity on a raindrop compare with the air drag it encounters when it falls at constant velocity?
18. How does the terminal speed of a parachutist before opening a parachute compare with terminal speed after? Why is there a difference?
19. How does the gravitational force on a falling body compare with the air resistance it encounters before it reaches terminal velocity? After?
20. Why is it that a cat that accidentally falls from the top of a 50-story building hits the ground no faster than if it falls from the 20th story?

Problems

1. One pound is the same as 4.45 newtons. What is the weight in pounds of 1 newton?
2. What is your own mass in kilograms? Your weight in newtons?
3. What is the acceleration of a 40-kg block of cement when pulled sideways with a net force of 200 N?
4. If a mass of 1 kg is accelerated 1 m/s^2 by a force of 1 N, what would be the acceleration of 2 kg acted on by a force of 2 N?
5. How much acceleration does a 747 jumbo jet of mass 30,000 kg experience in takeoff when the thrust for each of four engines is 30,000 N?
6. Gravity on the surface of the moon is only $1/6$ as strong as gravity on the Earth. What is the weight in newtons of a 10-kg object on the moon and on the Earth? What is its mass on each?