CAN YOU EXPLAIN THIS?

A wall can push.

You can push as hard as you wish against a wall, because the wall "pushes back." If the wall did not exert a reaction force equal and opposite to your push, you could not exert the push in the first place.

QUESTIONS

1. The unbalanced force required to accelerate a 2.0-kilogram mass at 4.0 meters per second squared is (1) 6.0 N (2) 2.0 N (3) 8.0 N (4) 16 N

2. A force of 10. newtons applied to a given mass accelerates it at 1.0 meter per second squared. The same force applied to a mass one-half as great would produce an acceleration of (1) 1.0 m/s^2 (2) 2.0 m/s^2 (3) 0.50 m/s^2 (4) 4.0 m/s^2

3. Which is a derived unit? (1) second (2) meter (3) kilogram (4) newton

4. An unbalanced force of 2.0 newtons acts on a 3.0-kilogram object for 6.0 seconds. The magnitude of the object's change in velocity is (1) 18 m/s (2) 2.0 m/s (3) 36 m/s (4) 4.0 m/s

5. If an unbalanced force of 50. newtons accelerates an object 20. meters per second squared, the mass of the object is (1) 0.40 kg (2) 2.5 kg (3) 70. kg (4) 1,000 kg

6. What unbalanced force must be applied to a 2.0-kilogram mass moving at 5.0 meters per second to give it an acceleration of 5.0 meters per second squared? (1) 0.40 N (2) 2.5 N (3) 10. N (4) 20. N

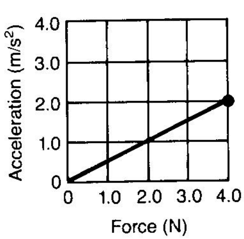
7. A 30.-kilogram child exerts a force of 100 newtons on a 50.-kilogram object. The force the object exerts on the child is (1) 0.0 N (2) 100 N (3) 980 N (4) 1,500 N

8. A car whose mass is 2,000 kilograms is accelerated uniformly from rest to a speed of 15 meters per second in 10. seconds on a level highway. The net force accelerating the car is (1) 2,000 N (2) 3,000 N (3) 20,000 N (4) 30,000 N

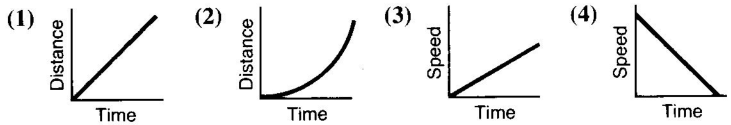
9. A certain net force causes a 10.-kilogram mass to accelerate at 20. meters per second squared. The same force will cause a 5.0-kilogram mass to accelerate at (1) 9.8 m/s^2 (2) 10. m/s^2 (3) 25 m/s^2 (4) 40. m/s^2

10. A car traveling at 15 meters per second on a level highway is brought to a stop in 10. seconds by a braking force of 3,000 newtons. The mass of the car is (1) 1,500 kg (2) 2,000 kg (3) 2,500 kg (4) 3,000 kg

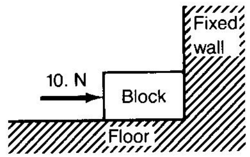
11. The graph at the right represents the relationship between the unbalanced force applied to a body and its acceleration. The mass of the body is (1) 1.0 kg (2) 2.0 kg (3) 0.5 kg (4) 8.0 kg



12. Which graph best represents the motion of an object on which the net force is zero?



13. What is the net force on the block shown at the right? (1) 0.0 N (2) 9.8 N (3) 10. N (4) 20. N



14. If the net force applied in the direction of motion to a certain object on a horizontal frictionless surface is doubled, the acceleration of the object is (1) halved (2) doubled (3) unchanged (4) quadrupled

15. A 10.-kilogram object is at rest on a horizontal frictionless table. What is the unbalanced force that must be applied to that object to give it a speed of 20. meters per second after 4.0 seconds? (1) 40. N (2) 50. N (3) 200 N (4) 800 N

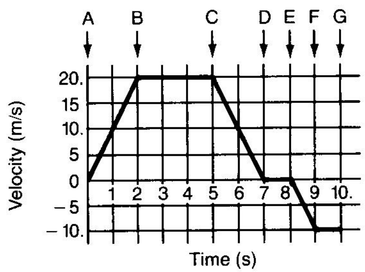
16. If the mass of an object is decreased, its inertia (1) decreases (2) increases (3) remains the same

17. If the sum of all the forces acting on a car is zero, the car (1) *must* be at rest (2) *may* be at rest (3) *must* be moving at constant speed (4) *must* be accelerating

18. As a constant unbalanced force acts on an object in the direction of motion, the object's speed (1) decreases (2) increases (3) remains the same

19. As the vector sum of all the forces acting on an object decreases, the acceleration of the object (1) decreases (2) increases (3) remains the same

20–24. Base your answers to Questions 20 through 24 on the graph at the right, which depicts the motion of a 2-kilogram mass that initially starts to move to the right along a straight-line path.



20. The mass has an acceleration of +10. meters per second squared during interval (1) *AB* (2) *BC* (3) *CD* (4) *EF*

21. How far does the 2-kilogram mass travel in the interval *AB*? (1) 10 m (2) 20 m (3) 30 m (4) 40 m

22. The net force on the 2-kilogram mass is zero during the interval (1) *AB* (2) *BC* (3) *CD* (4) *EF*

23. The 2-kilogram mass is at rest during interval (1) *AB* (2) *BC* (3) *DE* (4) *EFG*

24. There is a net force toward the left on the 2-kilogram mass for the time interval (1) *AB* (2) *BC* (3) *CD* (4) *FG*

Newton's Universal Law of Gravitation

All objects exert a force of attraction on each other, even when separated by large distances. This force is called **gravitation,** and it is assumed to act throughout the universe. Newton stated that any two masses attract one another with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. In mathematical form, this **universal law of gravitation** is:

$$F = \frac{Gm_1m_2}{r^2} \qquad \textbf{(Eq. 1-7)}$$

where F is the gravitational force in newtons between two objects, m_1 and m_2 are the masses of the objects in kilograms, r is the distance of separation in meters, and G is a proportionality constant equal to 6.67×10^{-11} N · m²/kg². The law holds for "point" masses, that is, masses whose sizes are small compared to the distance between them, and for spherical masses that are of uniform density. For spheres, the separation distance, r, is measured from the centers of the spheres.

Since r^2 appears in the denominator, the force of attraction between the masses decreases rapidly as the distance of separation increases. For example, if the distance of separation for two given masses is doubled, the force of attraction is quartered.

On the other hand, the force is directly proportional to the masses m_1 and m_2. If either mass is doubled, with distance remaining constant, the force is only doubled. If one mass is doubled and the other is tripled, the force will become six times the original force of attraction.

EXAMPLE

An object of 3.0 kilograms mass is located 1.0×10^4 meters from the center of an object of 2.0×10^9 kilogram mass in interstellar space. What is the gravitational force of attraction between the objects?

Solution

The force of attraction is given by Newton's law of gravitation:

$$F = \frac{Gm_1m_2}{r^2}$$