Contact Forces

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Friction is the resistance that arises at the surface between two bodies that are sliding against each other. It is one type of contact force.

Contact forces are some of the most familiar forces. Such forces typically involve pushes and pulls involving objects that are in physical contact.

Contact forces are distinct from so-called action-at-a-distance forces. The most familiar action-at-a-distance force is gravity. Visualize an object that is falling to the ground. The object and Earth are not in contact. But it is clear that the object is influenced by Earth's gravity.

Forces and Everyday Objects

In everyday experience, a force is an influence that has the ability to change a body's state of motion. That is, it may change the speed with which an object moves in a straight line. It may change the direction in which an object moves. Or it may do both.

It is also possible that a force will not cause any change in a body's state of motion. For example, one force may be canceled by another force or combination of forces. Think of a tug-of-war between evenly matched teams.

Failed attempts to alter a body's state of motion often involve friction. Imagine that someone is feebly pushing against a huge boulder. The boulder will not budge. The push is matched by friction between the boulder and the ground.

The person pushes harder. Still, the friction matches the push. The friction will equal the push that is applied until the push reaches a certain threshold value. (This value is called static friction.) Then the boulder's state of motion will change. Its speed in a particular direction will change from zero to some nonzero value.

Once the boulder is moving, keeping it in motion is easier. One may keep it moving at constant speed in a straight line by pushing just hard enough to match the object's kinetic friction. An object's kinetic friction is typically less than its static friction.

Analyzing the boulder's motion would be simpler if the boulder were not affected by friction. Any push, however feeble, would alter the boulder's state of motion. If it were applied long enough, even a tiny force would cause a noticeable change in velocity. Then, once the force was removed, the boulder would keep moving forever.

Whether friction is present or not, a net force is needed to alter an object's state of motion. Consider what happens when an applied force equals an object's kinetic friction. There is no net force. But the object will keep moving. That is, the object's velocity will stay the same. (Its speed and direction will not change.)

Friction Force

Friction is essential for many operations. It enables tires to grip roadways. It allows pulleys and belts to work. Even walking depends on friction. Slippery surfaces have reduced friction. Icy surfaces are a classic example.

The friction force is related to another surface interaction. This other interaction is called the normal force.

The friction force is tangent to the surface. That is, it may arise along the surface. The normal force is perpendicular to the surface. That is, it is at a right angle to the surface.

When dry surfaces slide, friction is proportional to the normal force. This is called Coulomb's friction law. In other words, a ratio exists between tangential and normal forces during sliding. This is called the coefficient of friction. It varies according to the nature of the two surfaces.

Air Resistance

Air resistance opposes the motion of objects passing through air. It is also called aerodynamic drag. Two forces contribute to air resistance. The first is frictional drag. It involves friction at the boundary between air molecules and an object's surface. The second is pressure drag. It involves air currents produced when objects plow through the air. Turbulence is a familiar example.

Net Force

Many objects are subject to a combination of forces. Consider someone pushing a chair. Friction resists the push. Gravity pulls the chair downward. Normal forces keep the chair and the floor from passing into each other.

As mentioned, all forces have both magnitude and direction. If these forces balance, a motionless object remains still. Or an object in motion maintains its straight-line motion.

A change in an object's state of motion requires a net force. A tug-of-war illustrates this concept. If both teams pull with equal force, everyone remains in place. If one team pulls harder, there is a net force. The weaker team is put into motion.

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