

## 26.1: Introduction

In our study of rotational and translational motion of a rigid body, we assumed that the rigid body did not undergo any deformations due to the applied forces. Real objects deform when forces are applied. They can stretch, compress, twist, or break. For example when a force is applied to the ends of a wire and the wire stretches, the length of the wire increases. More generally, when a force per unit area, referred to as stress, is applied to an object, the particles in the object may undergo a relative displacement compared to their unstressed arrangement. Strain is a normalized measure of this deformation. For example, the tensile strain in the stretched wire is fractional change in length of a stressed wire. The stress may not only induce a change in length, but it may result in a volume change as occurs when an object is immersed in a fluid, and the fluid exerts a force per unit area that is perpendicular to the surface of the object resulting in a volume strain which is the fractional change in the volume of the object. Another type of stress, known as a shear stress occurs when forces are applied tangential to the surface of the object, resulting in a deformation of the object. For example, when scissors cut a thin material, the blades of the scissors exert shearing stresses on the material causing one side of the material to move down and the other side of the material to move up as shown in Figure 26.1, resulting in a shear strain. The material deforms until it ultimately breaks.

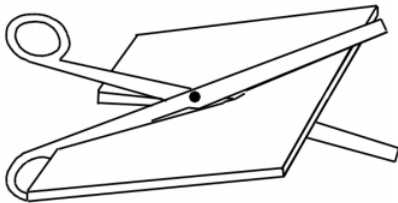


Figure 26.1: Scissors cutting a thin material

In many materials, when the stress is small, the stress and strains are linearly proportional to one another. The material is then said to obey Hooke's Law. The ratio of stress to strain is called the *elastic modulus*. Hooke's Law only holds for a range of stresses, a range referred to as the *elastic region*. An elastic body is one in which Hooke's Law applies and when the applied stress is removed, the body returns to its initial shape. Our idealized spring is an example of an elastic body. Outside of the elastic region, the stress-strain relationship is non-linear until the object breaks.

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