# Stiffness and shit

The stiffness, *k*, of a body is a measure of the resistance offered by an elastic body to deformation. For an elastic body with a single [degree of freedom](http://en.wikipedia.org/wiki/Degrees_of_freedom_%28mechanics%29) (DOF) (for example, stretching or compression of a rod), the stiffness is defined as

k=\frac {F} {\delta} 

where,

*F* is the force applied on the body

δ is the [displacement](http://en.wikipedia.org/wiki/Displacement_%28vector%29) produced by the force along the same degree of freedom (for instance, the change in length of a stretched spring)

## Rotational stiffness

A body may also have a rotational stiffness, *k*, given by

k=\frac {M} {\theta} 

where

*M* is the applied [moment](http://en.wikipedia.org/wiki/Moment_%28physics%29)

*θ* is the rotation

In the SI system, rotational stiffness is typically measured in [newton-metres](http://en.wikipedia.org/wiki/Newton-metre) per [radian](http://en.wikipedia.org/wiki/Radian).

In the SAE system, rotational stiffness is typically measured in inch-[pounds](http://en.wikipedia.org/wiki/Pound_%28force%29) per [degree](http://en.wikipedia.org/wiki/Degree_%28angle%29).

Further measures of stiffness are derived on a similar basis, including:

* shear stiffness - ratio of applied [shear](http://en.wikipedia.org/wiki/Shear_stress) force to shear deformation
* torsional stiffness - ratio of applied [torsion](http://en.wikipedia.org/wiki/Torsion_%28mechanics%29) moment to angle of twist

## Relationship to elasticity

In general, [elastic modulus](http://en.wikipedia.org/wiki/Elastic_modulus) is not the same as stiffness. Elastic modulus is a property of the constituent material; stiffness is a property of a structure. That is, the modulus is an [intensive property](http://en.wikipedia.org/wiki/Intensive_and_extensive_properties) of the material; stiffness, on the other hand, is an [extensive property](http://en.wikipedia.org/wiki/Intensive_and_extensive_properties) of the solid body dependent on the material *and* the shape and boundary conditions. For example, for an element in [tension](http://en.wikipedia.org/wiki/Tension_%28mechanics%29) or [compression](http://en.wikipedia.org/wiki/Compression_%28physical%29), the axial stiffness is

k=\frac {AE} {L} 

where

*A* is the cross-sectional area,

*E* is the (tensile) elastic modulus (or [Young's modulus](http://en.wikipedia.org/wiki/Young%27s_modulus)),

*L* is the length of the element.

Similarly, the rotational stiffness of a straight section is

k=\frac {GJ} {L} 

where

"J" is the [torsion constant](http://en.wikipedia.org/wiki/Torsion_constant) for the section,

"G" is the rigidity modulus of the material

Note that in SI, these units yield k : \frac{N \cdot m}{rad}. For the special case of unconstrained uniaxial tension or compression, [Young's modulus](http://en.wikipedia.org/wiki/Young%27s_modulus) *can* be thought of as a measure of the stiffness of a material.

## Applications

The stiffness of a structure is of principal importance in many engineering applications, so the [modulus of elasticity](http://en.wikipedia.org/wiki/Modulus_of_elasticity) is often one of the primary properties considered when selecting a material. A high modulus of elasticity is sought when [deflection](http://en.wikipedia.org/wiki/Deflection_%28engineering%29) is undesirable, while a low modulus of elasticity is required when flexibility is needed.

In biology, the stiffness of the [extracellular matrix](http://en.wikipedia.org/wiki/Extracellular_matrix) is important for guiding the migration of cells in a phenomenon called [durotaxis](http://en.wikipedia.org/wiki/Durotaxis).

## See also

* [Elasticity (physics)](http://en.wikipedia.org/wiki/Elasticity_%28physics%29)
* [Elastic modulus](http://en.wikipedia.org/wiki/Elastic_modulus)
* [Mechanical impedance](http://en.wikipedia.org/wiki/Mechanical_impedance)
* [Hardness](http://en.wikipedia.org/wiki/Hardness)
* [Hooke's law](http://en.wikipedia.org/wiki/Hooke%27s_law)
* [Moment of inertia](http://en.wikipedia.org/wiki/Moment_of_inertia)
* [Stiffness (mathematics)](http://en.wikipedia.org/wiki/Stiffness_%28mathematics%29)
* [Young's modulus](http://en.wikipedia.org/wiki/Young%27s_modulus)
* [Compliant mechanism](http://en.wikipedia.org/wiki/Compliant_mechanism)

# Collision, Elasitc and Inelastic

This is some pretty good shit, check it out.

http://spiff.rit.edu/classes/phys311.old/lectures/elas/elas.html

Although the momentum of individual objects may change during a collision, the total momentum of all the objects in an **isolated system** remains constant.

* **Completely inelastic** collisions involve objects which stick together afterwards. Kinetic energy is not conserved, but the result is easy to calculate via conservation of momentum.
* **Partially inelastic** collisions involve objects which separate after they collide, but which are deformed in some way by the interaction. Kinetic energy is not conserved. It's not easy to figure out what happens afterwards, because there are many possible solutions which satisfy conservation of momentum.
* **Elastic** collisions involve objects which separate after they collide, and which are not changed at all by the interaction. Billiard balls, ping-pong balls, and other hard objects may collide elastically. Kinetic energy *is* conserved in elastic collisions. One must use both conservation of energy *and* conservation of momentum to figure out the motions of the objects afterwards. This usually involves solving 2 equations for 2 unknowns.

# Elastic Collision Formula

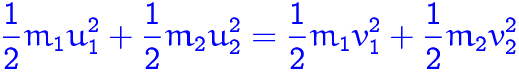
We have come across the word elastic for rubber balls, bands, balloons etc. So what are these elastic bodies?



Bodies are said to be elastic if even though the body deforms during collision it regains its original shape after the collision as shown in fig. The rubber balls shown above regains its shape even after collision.

Consider two elastic bodies of masses m1, m2 moving with initial velocity u1 and u2 towards each other undergoes collision.   
The **Elastic Collision formula** for momentum is given by

Ellastic Collision FormulaWhere **m1** = Mass of first body ,

**m2** = Mass of second body,  
**u1** = Initial velocity of first body,  
**u2** = Initial velocity of second body,   
**v1** = Final velocity of first body,  
**v2** = Final velocity of second body.  
*Which says that "Momentum before collision is equal to the momentum after collision".*  
  
The **Elastic Collision formula** for kinetic energy is given by  


Elastic Collision formula is used to calculate the mass or velocity of the elastic bodies.

**Solved Examples**

**Question 1:** A ball of mass 2 Kg is moving with the velocity of 12 m/s collides with a stationary ball of mass 6 kg and comes to rest. Calculate the velocity of ball of mass 6 Kg ball after collision. (Both balls are elastic).  
**Solution:**

Given: Mass of first ball m1 = 2 kg,   
          Initial Velocity of the first ball U1 = 12 m/s,   
          Mass of the second ball, m2 = 6 kg,   
          Initial velocity of the second ball, u2 = 0,   
          Final Velocity of first ball, v1 = 0,   
          Final Velocity of second ball, v2 = ?.   
The elastic collision formula is given by  
 12 m1u12 + 12 m2u22 = 12 m1v12 + 12 m2 v22   
 12 × 2 × 122 + 12 × 5 × 0 = 12 × 2 × 02 + 12 × 6 × v22  
 2 × 144 + 0 = 0 + 3v2   
288 = 3 v2  
v2 = 96  
v = 96−−√   
  = 4 6√ m/s.

**Question 2:** A 10 Kg block moving with initial velocity of 12 m/s with 6 Kg wooden block moving towards the first block with velocity 4 m/s. After collision the second body comes to rest .Calculate the final velocity of first body?(Collision is elastic).  
**Solution:**

Given:Mass of first ball m1 = 10 kg,  
         Initial Velocity of the first ball u1 = 12 m/s,  
         Mass of the second ball, m2 = 6 kg,  
         Initial velocity of the second ball, u2 = 4 m/s,  
         Final Velocity of first ball, v1 = ?,  
         Final Velocity of second ball, v2 = 0.  
The Elastic collision formula is given by  
m1u1 + m2u2 = m1v1 + m2v2  
10 × 12 + 6 × 4 = 10 × v1 + 6 × 0  
120 + 24 = 10 v1 + 0  
144 = 10 v1  
∴ Final velocity of the first body v1 = 14.4 m/s.