Section 6.7 Physical Applications

# Topic 1: Density and Mass

Density is the concentration of mass in an object and is usually measured in units of mass per volume (e.g. ). An object with uniform density satisfies the basic relationship

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When the density of an object varies, this formula does not hold, and calculus is needed to find the mass of the object.

**Mass of a One-Dimensional Object**

Suppose a thin bar or wire is represented by the interval  with a density function  (with units of mass per length). The **mass** of the object is

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# Topic 2: Work

Work can be described as the change in energy when a force causes a displacement of an object. If a constant force displaces an object some distance in the direction of the force, then the work done can be calculated with the formula



A newton (N) is the force required to give a 1  mass an acceleration of 1 . A joule (J) is 1 newton-meter (1 N-m), the work done by a 1 N force over a distance of 1 m.

Calculus is needed to calculate work when variable forces are involved.

The **work** done by a variable force *F* in moving an object along a line from  to  in the direction of the force is

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One application of force and work is the stretching and compression of a spring.

According to Hooke’s Law, the force required to keep the spring in the compressed or stretched position *x* units from the equilibrium position is given by , where the positive spring constant *k* measures the stiffness of the spring. To stretch the spring to a position , a force  (in the positive direction) is required. To compress the spring to a position , a force  (in the negative direction) is required.

