

AP Physics C

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Part I

Mechanics

Chapter 1

Rotations

1.1 Rotation

A **rigid body** rotates as a unit.

The axis about which an object rotates is the **axis of rotation**. The **angular position** θ of this line is taken relative to a fixed direction, the **zero angular position**.

Although its can be changed (if specified), positive angles are conventionally **counterclockwise** from the zero angular position.

Angular dimension is measured using **radians** (**rad**), which are dimensionless.

$$\theta = \frac{s}{r}$$

A **revolution** is equal to 360° which is also equal to 2π rad.

1.2 Rolling, Torque, and Angular Momentum

For an object to **roll** is for it to move rotationally and translationally along a surface. For an object to roll **smoothly** is for it not to leave the ground while it is rolling.

Smooth rolling can be thought of as pure rotation and pure translation or as rotation about a moving contact point.

The center of mass of a rolling object moves parallel to the surface. The rest of the object rotates about the center of mass.

The **arc distance** S , the distance covered on the surface, and the velocity about the center of mass are defined as linear variables:

$$S = \theta r$$

$$v_{\text{com}} = \omega r$$

As rolling objects move both translationally and rotationally, they have both translational and rotational kinetic energy.

$$K = \frac{1}{2}I_{\text{com}}\omega^2 + \frac{1}{2}Mv_{\text{com}}^2$$

For an object to roll smoothly, friction is required.

If no slipping occurs, then energy is conserved (even with friction).