Physics I

Kinetic Energy

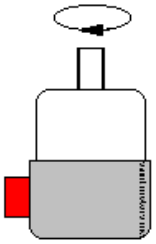
Kinetic energy in linear motion $K.E. = \frac{1}{2}mv^2$

Kinetic energy in rotational motion $K.E. = \frac{1}{2}I\omega^2$

Average kinetic energy in gas molecules due to thermal motion of their center of mass:

$$\langle KE \rangle = \frac{3}{2}k_B T = \frac{1}{2}mv_{rms}^2$$

Problem 1.- Calculate the kinetic energy stored in the rotor of an electric motor whose radius is 0.25m, mass 16kg and angular velocity 3600 rpm. Approximate the moment of inertia of the rotor to one of a solid cylinder: $\frac{1}{2}MR^2$.



Problem 1a.- Calculate the kinetic energy stored in an audio CD when it rotates at its maximum speed of 500 rpm (revolutions per minute). Approximate the moment of inertia of the CD to one of a disk: $\frac{1}{2}MR^2$, consider its mass to be 0.015kg and its radius 0.060m

Problem 1b.- Calculate the total kinetic energy of a barrel that rolls without slipping at 4.0m/s if its mass is 120kg and its radius is 0.35m. Assume that it is a solid cylinder. (Moment of inertia of a solid cylinder =1/2MR^2)

Problem 2.- Calculate the rms speed of a molecule that has a mass of 75 amu if the temperature is 37ºC.
1 amu = 1.66×10^{-27} kg

Problem 2a.- At room temperature (300K), a helium atom, with mass 4 amu, typically has a kinetic energy of 6.21×10^{-21} J. Calculate its speed.
1 amu = 1.66×10^{-27} kg

Problem 2b.- In principle, can we separate N_2 from O_2 by diffusion? What is the ratio of speeds of these two molecules at room temperature?

Problem 2c.- Calculate the rms speed of hydrogen molecules present in the atmosphere at T=27ºC.

Problem 3.- Calculate the kinetic energy stored in a rotating hydrogen molecule that has a moment of inertia of I = 9.56×10^{-48} kgm^2 and is in the first rotational excited state that has an angular momentum squared $L^2 = 2\hbar^2$, where $\hbar = 1.05\times10^{-34}\,Js$

Problem 4.- Which has more energy: An 80-kg athlete running at 8.5m/s or a 7-g bullet at 350 m/s?

Problem 5.- A person works out in the stair machine for a while. The work done is equivalent to a real climb of 150 meters. Calculate how many Calories were burnt if the person has a mass of 60kg and the efficiency is 20%.

Problem 6.- A 855-kg car applies a braking force of 4880N on the pavement. Calculate the distance needed to stop the car if it is going at 65 miles per hour.