Shock Absorbers

Bumps in the road are certainly a nuisance, but without strategic use of damping devices, they could also prove deadly. To control a car going 110 km/h (70 mi/h), a driver needs all the wheels on the ground. Bumps in the road lift the wheels off the ground and rob the driver of control. A good solution is to fit the car with springs at each wheel. The springs absorb energy as the wheels rise over the bumps and push the wheels back to the pavement to keep the wheels on the road. However, once set in motion, springs tend to continue to go up and down in simple harmonic motion. This affects the driver's control of the car and can also be uncomfortable.

One way to cut down on unwanted vibrations is to use stiff springs that compress only a few centimeters under thousands of newtons of force. Such springs have very high spring constants and thus do not vibrate as freely as softer springs with lower constants. However, this solution reduces the driver's ability to keep the car's wheels on the road.

To completely solve the problem, energy-absorbing devices known as *shock absorbers* are placed parallel to the springs in some automobiles, as shown in part (a) of the illustration below. Shock absorbers are fluid-filled tubes that turn the simple harmonic motion of the springs into damped harmonic motion. In damped harmonic motion, each cycle of stretch and compression of the spring is much smaller than the previous cycle. Modern auto suspensions are set up so that all of a spring's energy is absorbed by the shock absorbers, eliminating vibrations in just one up-and-down cycle. This keeps the car from continually bouncing without sacrificing the spring's ability to keep the wheels on the road.

Different spring constants and shock absorber damping are combined to give a wide variety of road responses. For example, larger vehicles have heavy-duty leaf springs made of stacks of steel strips, which have a larger spring constant than coil springs do. In this type of suspension system, the shock absorber is perpendicular to the spring, as shown in part (b) of the illustration. The stiffness of the spring can affect steering response time, traction, and the general feel of the car.

As a result of the variety of combinations that are possible, your driving experiences can range from the luxurious floating of a limousine to the bone-rattling road feel of a sports car.