An Inexpensive Apparatus for Demonstrating Magnetic Levitation

Carlos Saraiva, School EB 2, 3 de Vila Franca das Naves, 6420-707, Vila Franca das Naves, Portugal; carlos.saraiva1@gmail.com

One way of simulating magnetic levitation is by placing a rotating aluminum disk under a magnet. In this article, I will explain how to make an inexpensive apparatus to verify this effect, by recycling an obsolete computer.

The hard disk drive of a computer was opened, and the head actuator and the neodymium-iron-boron (NdFeB) magnet removed in order to use the drive motor. The hard information-storage disks (platters) were also removed and replaced by an aluminum disk.

The magnet was glued to one end of a plastic ruler. On the other end of the ruler, a movable counterweight was attached to balance the magnet. A polyvinylchloride (PVC) tube was glued to the middle of the ruler, and a metallic cylindrical rod attached to a wooden base was put inside this tube so that the ruler could pivot freely (see Fig. 1). The magnet is balanced above the aluminum disk (near its periphery) by adjusting the position of the counterweight so as to keep the ruler horizontal. When the motor of the hard disk is off, the ruler remains motionless. But when the motor is switched on (with the power supply) and the aluminum disk rotates, the magnet is repelled and the ruler begins to tilt upward as the magnet rises. As the speed of the motor increases, the magnet lifts further. If one tries to push the magnet toward the disk using a finger, one can feel there is a magnetic force. The rotation of the aluminum disk in the presence of the magnet causes magnetic flux changes and an induced current appears (Faraday's law). These currents are called eddy currents. The eddy currents produced by the magnet create a magnetic field in the disk that will oppose the field of the suspended magnet (Lenz's law). Due to this interaction, the magnet experiences a repulsive force that makes it levitate (Fig. 1). It is important for students to repeat this demonstration with a disk made of nonconductive material (plastic or ceramic). In this case they will verify that the magnet does not levitate.

The lifting of the magnet depends on the intensity of its magnetic field and of the angular velocity of the disk. This effect is used, for example, in cars to measure the speed of the vehicle.

We can use this apparatus for observing the braking of a metallic disk by the action of magnetic fields. First we switch on the motor, then switch it off and measure the time it takes the aluminum disk to stop when there is no magnet present (our disk took about 16 seconds!). Then we repeat this procedure, but after switching the motor off, we move the magnet close to the disk's periphery and measure the stopping time again (this only took about 3 seconds!). This demonstration is more effective if one uses neodymium-iron-boron magnets since they create substantial magnetic fields, typically about 0.2 T.

References


PACS codes: 01.50.My, 40.00.00