# Teacher Guide

This lesson is about the aerodynamic forces acting on a kite during its flight. The nature of forces acting on a kite is very similar to that on a flying airplane. The forces acting on a kite are drag and lift by air, gravity due to weight and a pull force by the string attached to it. The bridle of the kite is made in such a way that it causes the kite to feel the upward life force due to air/wind.  In this lesson, once the kite is airborne and stable, a spring is used to measure the force being exerted by air.  Then using the drag equation, the wind velocity was determined.

The lesson starts with a comparison of the two flying objects, i.e., an airplane and a kite.  In order to understand forces, a free body diagram of forces is drawn and net resultant force is determined. The free body diagram simplifies the number of forces acting on an object and then helps to determine the net force acting on that object. When an object is in a medium like air or water, then the medium exerts force on all surfaces exposed to that medium. It is important to explain to students about the pressure exerted by that medium on the objects and how different surfaces can have different pressures leading to either a drag or an upward lift (in the case of a kite or a plane). A figure has been plotted in the section "teacher's guide" to explain in detail the number of forces on a kite.

In this lesson, a simple experiment using a spring was designed to measure the drag force. First students should be asked to prove Hooks law by plotting the extension of the spring as a result of weight attached to it. Students should be asked to explain the linear relation of the force with extension and to determine the spring constant from the slope of the line. In the end a calibrated spring may be used to measure the unknown force as done in the lesson.

The drag force by air on the kite was measured by using

$$=12 \quad (\quad) \quad 2$$

where $C_D$ is the drag coefficient. In fluid dynamics, the **drag coefficient** ($c_D$) is a dimensionless quantity that is used to quantify the drag or resistance of an object in a fluid environment such as air or water. It is used in the drag equation, where a lower drag coefficient indicates the object will have less aerodynamic or hydrodynamic drag. The drag coefficient is always associated with a particular surface area.  It is determined experimentally in a wind tunnel. It is interesting to explain the drag force of air on various shaped objects and the flow patterns of air around those shapes. The wing of an airplane is the best example. There can be many different examples to quote to students, e.g., swing ball (foot ball or a tennis ball), where pressures on two sides of the ball becomes different to make it swing.

Finally, a simple example of a rain drop or parachute can be given to students to help understand the drag force and its magnitude.