**Physical Education and Sports**

**Grade 13**

**Types of Forces**

**Friction**

Friction is the resistance to motion of one object moving relative to another. It is not a fundamental force, like gravity or electromagnetism. Instead, scientists believe it is the result of the electromagnetic attraction between charged particles in two touching surfaces.

Scientists began piecing together the laws governing friction in the 1400s, but because the interactions are so complex, characterizing the force of friction in different situations typically requires experiments and can't be derived from equations or laws alone.

For every general rule about friction, there are just as many exceptions. For instance, while two rough surfaces (such as sandpaper) rubbing against each other sometimes have more friction, very smoothly polished materials (such as plates of glass) that have been carefully cleaned of all surface particles may actually stick to each other very strongly.

**Types of friction**

There are two main types of friction, static friction and kinetic friction. Static friction operates between two surfaces that aren't moving relative to each other, while kinetic friction acts between objects in motion.

In liquids, friction is the resistance between moving layers of a fluid, which is also known as viscosity. In general, more viscous fluids are thicker, so honey has more fluid friction than water.

The atoms inside a solid material can experience friction as well. For instance, if a solid block of metal gets compressed, all the atoms inside the material move, creating internal friction.

In nature, there are no completely frictionless environments: even in deep space, tiny particles of matter may interact, causing friction.

## Coefficient of friction

Two solid objects moving against each other experience kinetic friction. In this case, the friction is some fraction of the perpendicular force acting between two objects (the fraction is determined by a number called the coefficient of friction, which is determined through experiments). In general, the force is independent of the contact area and doesn't depend on how fast the two objects are moving.

Friction also acts in stationary objects. Static friction prevents objects from moving and is generally higher than the frictional force experienced by the same two objects when they are moving relative to each other. Static friction is what keeps a box on an incline from sliding to the bottom.

## Applications of friction

Friction plays an important part in many everyday processes. For instance, when two objects rub together, friction causes some of the energy of motion to be converted into heat. This is why rubbing two sticks together will eventually produce a fire.

Friction is also responsible for the wear and tear on bike gears and other mechanical parts. That's why lubricants, or liquids, are often used to reduce the friction — and wear and tear — between moving parts.

**Ground Reaction Force**

For every action, according to Newton's 3rd Law of Motion (Law of Reaction), there is an equal and opposite reaction. Due to the gravity, we constantly maintain contact with the ground, and in this process, there occur interactions between the body and the ground.

The reaction force supplied by the ground is specifically called the **ground reaction force**(**GRF**), which is basically the reaction to the force the body exerts on the ground. The GRF, along with the weight, is an important external force. The GRF is normally measured by a force-plate.

Figure 1a shows the reference frame of the force-plate, with the Z- axis being the vertical. The interaction between the body and the ground occurs through the foot as shown in Figures 1b, which shows the reaction force vectors acting on small areas. A force-plate normally has four tri-axial force sensors embedded that measure the force acting between the foot and the ground in 3 axes: transverse (X), anteroposterior (Y), and vertical (Z). Figure 1c show the 4 reaction force vectors measured by the sensors. The sum of all the reactions from the ground shown in Figure 1b is equivalent to the sum of the four forces measured by the sensors (**F**1, **F**2, **F**3, & **F**4) shown in Figure 1c. Thus, system (b) is equivalent to system (c).

