Grade 11 Physics Notes - Part Two

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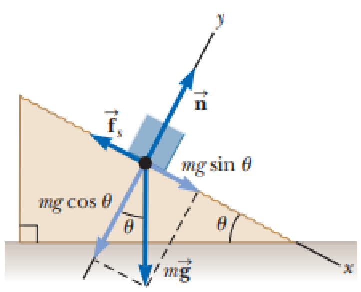
Friction

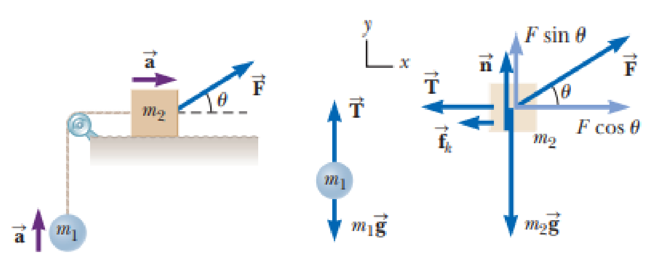
We saw that friction is directly proportional to the normal force. Thus,

$$F_f \ \alpha \ F_n$$
$$F_f = \mu F_n$$

For computing forces as vectors, we should define axes and a coordinate system for the system. Let's look at an object rolling down an inclined plane. In this case we define our axes so that the level of the incline is our X-axis and the line perpendicular be the Y-axis.



In this case, choosing our axes this way helps us simplifies adding up forces. For a case where we have two boxes attached to each other with an inextensible string, we can define axes and compute forces as follows.



As we see in the figure above, we separate the forces along the axes convenient to add up the forces.

Newton's Law of Gravitation

Newton's law states that for two masses in space, there is a force of attraction between the two masses. The force is directly proportional to the product of the masses and inversely proportional to the square of the separation between them.

Thus,

$$F_g \ \alpha \ \frac{M_1 M_2}{r^2}$$

The constant of proportionality for this relationship is called the Gravitational Constant(G).

$$F_g = \frac{G M_1 M_2}{r^2}$$

One common phenomenon that always arises with gravitation is planetary motion. In planetary motion, a smaller mass(such as a natural or artificial satellite) rotates about a larger mass(a planet).

For an object moving about a circle, the net force acting on it around its radial axis is called the centripetal force(F_c). It is given by:

$$F_c = m\frac{V^2}{r}$$

In planetary motion, an object's(m) motion around a larger mass(**M**) can be effectively considered circular and if we assume the only force acting between the two to be gravitation, we have the following.

$$F_c = F_g$$

$$m\frac{V^2}{r} = \frac{GMm}{r^2}$$

$$V^2 = \frac{GM}{r}$$

$$V = \sqrt{\frac{GM}{r}}$$

This velocity, V, is called the orbital velocity of the smaller mass around the larger mass. We see that its independent of the mass of the smaller object. Thus, we can express the velocity just in terms of the gravitational acceleration(**g**).

$$g = \frac{GM}{r^2}$$

Thus,

$$V = \sqrt{\frac{GM}{r^2}r}$$

$$V = \sqrt{\mathbf{g}r}$$

Law of Conservation of Momentum

Whenever we hear the word momentum, we , we get the implication of a tendency to continue on course—to move in the same direction—and is associated with great mass and speed. It is important to recognize that this momentum is a vector quantity and hence the direction to which the object is moving is important.

The linear momentum of an object, denoted by **P**, is given by:

$$\mathbf{P} = m\mathbf{v}$$

Let's assume there is a an isolated system where the net force acting on it is, we have the following:

$$F = ma$$

$$F = m(\frac{v_f - v_i}{t})$$

$$Ft = m(v_f - v_i)$$

IF the net force is 0, we have the following

$$0 = m(v_f - v_i)$$

$$mv_f - mv_i = 0$$

$$P_f - P_i = 0$$

$$\Delta\mathbf{P} = 0$$

This implies that the change in momentum of an isolated system where the net force on it is 0, the linear momentum of the system is conserved.