31 How Hot Are Your Wheels?

Experiment

Purpose

To measure the efficiency of a toy car on an inclined track

Required Equipment/Supplies

toy car
3 m of toy car track
meterstick
tape
2 ring stands
2 clamps

Discussion

According to the law of energy conservation, energy is neither created nor destroyed. Instead, it *transforms* from one kind to another, finally ending up as heat energy. The potential energy of an elevated toy car on a track transforms into kinetic energy as the car rolls to the bottom of the track, but some energy becomes heat because of friction. The kinetic energy of the car at the bottom of the track is transformed back into potential energy as the car rolls to higher elevation, although again some of the energy becomes heat. The car does not reach its initial height when it moves back up the incline, because some of its energy has been transformed into heat.

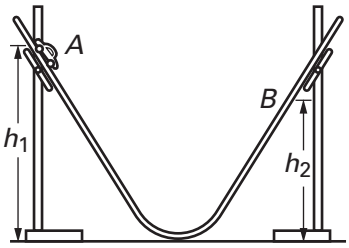

Fig. A

Procedure

Set up track.

Step 1: Set up a toy car track as shown in Figure A. Both ends of the track should be elevated to a height of 1 meter above the table or floor. Secure the track to the table or floor and supporting ring stands with tape to eliminate motion of the track.

Measure the initial and final height of the car.

Step 2: Mark starting point *A* with a piece of masking tape and record its height h_1. Release the car from starting point *A*. Record the height h_2 of point B to which the car rises on the other end of the track.

h_1 = _____

h_2 = _____

Compute efficiency.

Step 3: Efficiency is defined as the useful energy out divided by the total energy in. It is a ratio or a percentage. In this activity, we can define the total energy *in* as the change in potential energy as the car rolls from its

highest to its lowest point. This is energy supplied by earth's gravity. The useful energy out we can take to be the potential energy change as the car rolls from its lowest point until it stops at point *B*. This is energy that the car now possesses relative to the lowest point of its travel. Since the potential energy at any height *h* above a reference level is *mgh*, the ratio of the potential energy transferred back into the car at point *B* (the output energy) to the potential energy lost by the car in rolling down to point *A* (the input energy) is equal to the ratio of the final height h_2 to the initial height h_1. This ratio of h_2 to h_1 can be called the "efficiency" of the car-and-track system from point *A* to point *B*. It shows the fraction of the energy supplied by gravity in rolling down the track that is retained after it rolls up the track. Compute this efficiency.

$$\text{efficiency} = \frac{\text{PE}_{\text{point } B}}{\text{PE}_{\text{point } A}} = \frac{h_2}{h_1}$$

Analysis

1. Is the efficiency of the car-and-track system changed if the track is not taped?

2. In what units is efficiency measured?

3. Is the efficiency of the car-and-track system changed if the height of the track is altered?