

Energy on an Inclined Plane

One focus of study in physics is the concept of energy. There are two forms of mechanical energy that are of interest to physicists – kinetic energy and potential energy. Kinetic energy is the energy associated with an object’s motion (i.e., its velocity). Potential energy is the energy stored in an object as a result of its vertical position (height). The total amount of mechanical energy is the sum of these two forms of energy.

A group of physics students are studying the relationship between the potential energy (PE), kinetic energy (KE) and total mechanical energy (TME) for a cart rolling up and down an incline. A computer-interfaced motion detector is placed at the top of the incline to detect changes in the height and the speed of the cart. The students start the detector, hold the cart for about 1.0 seconds and then give it a gentle push up the hill. The computer generates plots showing the position and height as a function of time. See **Figure 1**.

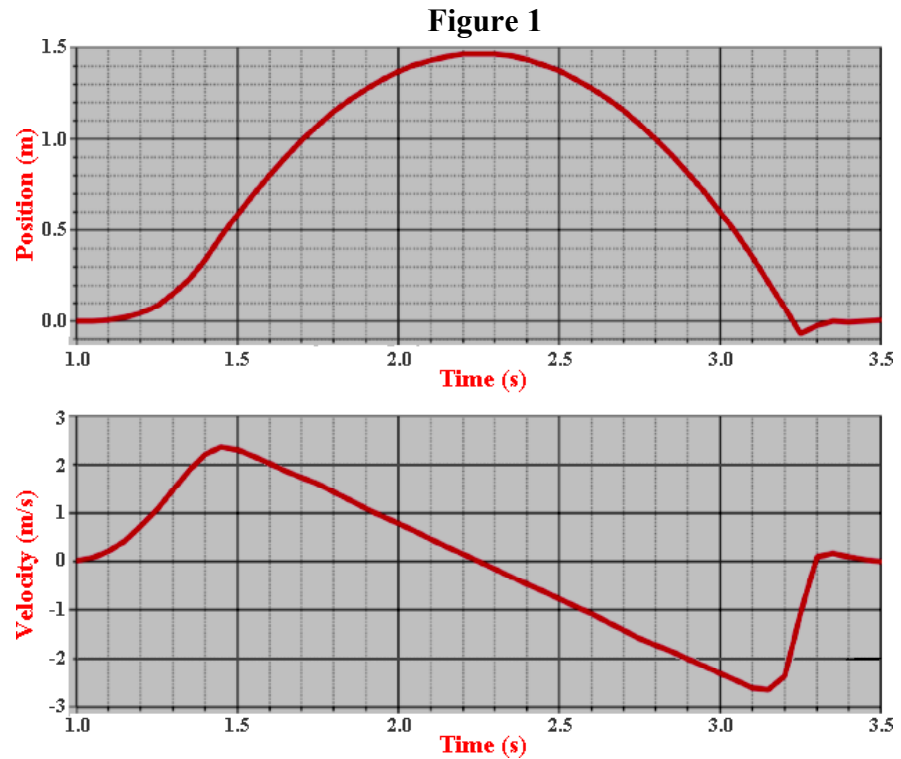
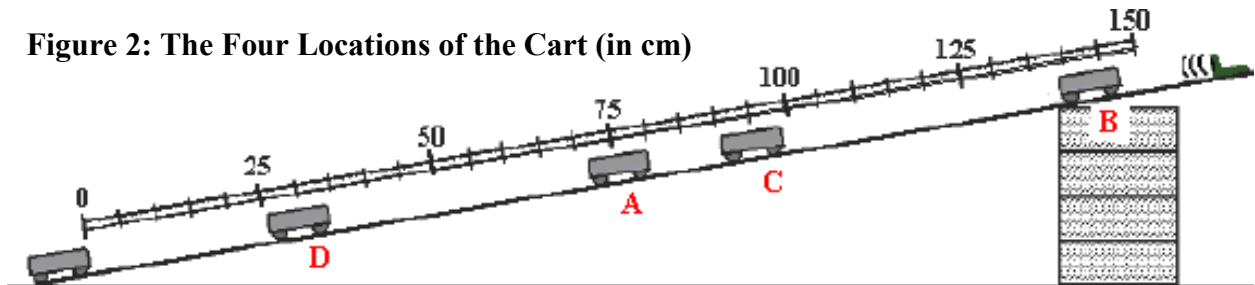


Figure 2: The Four Locations of the Cart (in cm)



The students analyze the graphs to determine the height above the table and the velocity at four different locations along the incline plane. See location labels (A, B, C and D) on **Figure 2**. The position values are in units of centimeters (cm). Location B is the highest point reached by the cart along the track. Using height and velocity values, the students calculate the KE, PE and TME for the four locations. See **Table 1**.

Table 1: Energy Values of Cart

Location	KE (J)	PE (J)	TME (J)
A	0.505	0.603	1.108
B	0.000	1.107	1.107
C	0.366	0.743	1.109
D	0.845	0.263	1.108

Questions:

1. Which graph must the students use to determine the kinetic energy of the cart?
 - a. The position versus time graph must be used.
 - b. The velocity versus time graph must be used.
 - c. Both the position and the velocity versus time graphs must be used.
 - d. Neither graph is used. The kinetic energy values are calculated without using the graphs.

2. At which of these listed times does the cart have the lowest kinetic energy?
 - a. At 1.10 seconds.
 - b. At 2.25 seconds.
 - c. At 2.55 seconds.
 - d. At 3.12 seconds.

3. The formula for calculating the kinetic energy is $KE = 0.5 \cdot m \cdot v^2$ where **m** represents the mass in kilograms and **v** represents the velocity in meter/second. How does the kinetic energy (KE) of the cart at 1.60 seconds compare to the kinetic energy (KE) of the cart at 1.92 seconds?
 - a. The KE at 1.60 seconds is about the same as the KE at 1.92 seconds.
 - b. The KE at 1.60 seconds is about one-half the value of the KE at 1.92 seconds.
 - c. The KE at 1.60 seconds is about two times greater than the KE at 1.92 seconds.
 - d. The KE at 1.60 seconds is about four times greater than the KE at 1.92 seconds.
 - e. The KE at 1.60 seconds is about one-fourth the value of the KE at 1.92 seconds.

4. For which of the following positions along the track does the cart have the greatest kinetic energy?
 - a. 30 cm
 - b. 50 cm
 - c. 90 cm
 - d. 140 cm

5. Which one of the following statements best describes the relationship between the cart's kinetic energy (KE), potential energy (PE) and total mechanical energy (TME).
 - a. As the PE increases, the KE and the TME are also observed to increase.
 - b. As the PE increases, the KE decreases, but the TME remains relatively constant.
 - c. The TME increases as the PE increases, but the KE remains relatively constant.
 - d. There seems to be no pattern in the manner in which the KE, PE and TME change.

6. Which combination of kinetic energy (KE), potential energy (PE) and total mechanical energy (TME) values would be expected when the cart is located at a position of 90 cm (0.90 m) from its starting location?
 - a. KE = 0.43 J, PE = 0.68 J, TME = 1.11 J
 - b. KE = 1.80 J, PE = 1.63 J, TME = 3.43 J
 - c. KE = 1.63 J, PE = 1.80 J, TME = 3.43 J
 - d. KE = 0.26 J, PE = 0.85 J, TME = 1.11 J