Module 09

Work and Energy Conservation

QUESTIONS

Question 1 (LV1): How much work do you do as you exert a 75-N force to push a shopping cart through a grocery store isle for 10 m?

Question 2 (LV2): You apply a 500-N force to push a couch. The force is applied at an angle of 15° with respect to the direction of motion of the couch as you do 1000 J of work. How far do you push the couch?

Question 3 (LV3): The force acting on an object is given by $F_x = (5x + 10)$ N, where x is in meters. Calculate the net work done by the force as the object moves from $x = 1.00$ m to $x = 4.00$ m.

Question 4 (LV4): A boy pushes a 60.0-kg sled (including his friend in it) starting from rest for a distance of 10.0 m with a horizontal and constant force of 150.0 N. Calculate the work done by the applied force on the sled and the speed of the sled at the end of the 10.0-m distance.

Question 5 (LV5): A woman with a mass of 50 kg climbs a staircase that rises at 60° above the horizontal and has a length of 5.0 m. How much work has gravity done on her as she climbed the stairs?

Question 6 (LV6): A particle moves under the influence of a force described by a potential $U(x) = 20x^2 - 4.0$, where U is measured in joules and x is measured in meters. Find the force on the particle when it is located at $x = -1.5$ m.

Question 7 (LV7): A spring of constant $k = 500$ N/m is used to launch a 59.0-g tennis ball. If the spring is compressed by 20 cm for the launch, how fast will be ball move

immediately after the launch?

Question 8 (LV8): What average mechanical power must be delivered by the muscles of a 80.0-kg mountain climber who climbs a summit of height 300 m in 90.0 min?

PROBLEMS

Problem 1 (LV1, LV4, LV7): A 200-g box slides on a frictionless surface with a speed of $v = 4.00$ m/s. After a while it reaches a surface with a coefficient of kinetic friction μ_k. This frictional surface extends $s = 100$ cm and it is followed by a frictionless curved rise, as shown in Fig. 1. The box stops at a height $h = 50$ cm. What is the value of the coefficient of kinetic friction?

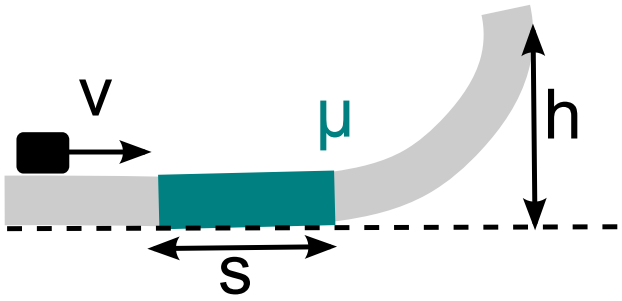

FIG. 1: Block travelling on partially frictional surface.

Problem 2 (LV5, LV7): A toy-train of mass 250.0 g is sliding across a smooth, level surface track at 2.0 m/s when it hits a stationary spring bumper, fixed at one end as shown in Fig. 2, whose force constant is 300 N/m. By what amount does the train compress the spring, before coming to rest?

FIG. 2: Toy-train stopped by spring compression.

Problem 3 (LV1, LV4): An 8.0-g bullet moving at 500 m/s hits a tree and goes 4.00 cm deep into the tree trunk. (a) Find the average frictional force that stops the bullet. (b) Assuming the frictional force is constant, determine how much time elapses between the moment the bullet enters the tree and the moment it stops moving.

Problem 4 (LV8): A cardiologist is performing a stress test for an 80-kg patient. The test consists of rapid walking on an inclined treadmill. The patient has to reach a peak power output of 400 W against the gravitational force experienced on the inclined treadmill. If the patient's maximum walking speed is 6.0 km/h, what is the treadmill's inclination angle in order to reach the maximum power output?