KINETIC ENERGY

Mass m is in kilograms, velocity or speed v is in meters per second, and kinetic energy KE is in kilogram · meter^2/second^2 or joules.

SAMPLE PROBLEM

Calculate the kinetic energy possessed by a 2.7-kilogram cart traveling at 1.5 meter per second.

SOLUTION: Identify the known and unknown values.

Known	*Unknown*
$m = 2.7$ kg	$KE = ?$ J
$v = 1.5$ m/s	

1. Write the formula for kinetic energy.

$$KE = \frac{1}{2}mv^2$$

2. Substitute the known values and solve.

$$KE = \frac{1}{2}(2.7 \text{ kg})(1.5 \text{ m/s})^2 = 3.0 \text{ J}$$

Note: If the weight of the cart had been given, it would have been necessary to use the formula

$g = \frac{F_g}{m}$ to determine the cart's mass.

Review Questions NAME:

57. If the speed of a car is doubled, its kinetic energy is

(1) halved
(2) doubled
(3) quartered
(4) quadrupled

58. A 1.0×10^3-kilogram car is moving at a constant speed of 4.0 meters per second. What is the kinetic energy of the car?

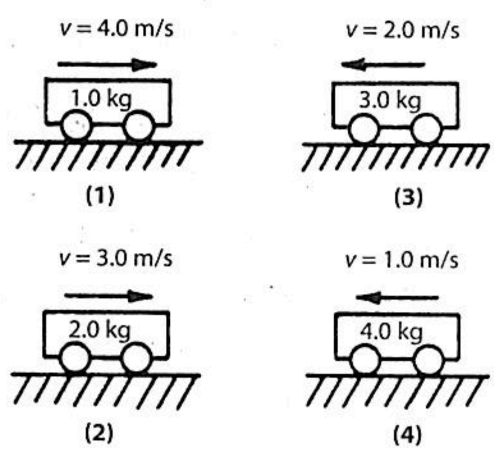
(1) 1.6×10^3 J
(2) 2.0×10^4 J
(3) 8.0×10^3 J
(4) 4.0×10^3 J

59. A 3.0-kilogram cart possesses 96 joules of kinetic energy. Calculate the speed of the car.

60. A cart of mass m traveling at speed v has kinetic energy KE. If the mass of the cart is doubled and the speed is halved, the kinetic energy of the cart will be

(1) half as great
(2) twice as great
(3) one-fourth as great
(4) four times as great

61. Which cart has the greatest kinetic energy?



62. A 2.0-kilogram cart is initially at rest on a level floor. Determine the kinetic energy of the cart after a constant horizontal 8.0-newton force is applied to the cart over a distance of 1.5 meters.

63. A person does 100 joules of work in pulling back the string of a bow. What is the initial speed of a 0.5-kilogram arrow when it is fired from the bow?

(1) 20 m/s
(2) 50 m/s
(3) 200 m/s
(4) 400 m/s

64. An 8.0-kilogram object and a 4.0-kilogram object are released simultaneously from a height of 50. meters above the ground. After falling freely for 2.0 seconds, the objects have different

(1) accelerations
(2) speeds
(3) kinetic energies
(4) displacements

65. The work done in raising an object must result in an increase in the object's

(1) internal energy
(2) kinetic energy
(3) gravitational potential energy
(4) elastic potential energy

66. Two cars having different weights are traveling on a level surface at different constant velocities. Within the same time interval, greater force is always required to stop the car that has the greater

(1) weight
(2) kinetic energy
(3) velocity
(4) momentum

Work-Energy Relationship

If there is no friction, all the work done in lifting an object to a new height is equal to the object's increase in gravitational potential energy. The change in potential energy depends only on the change in height, not on the path taken. For example, the work done in lifting a 10.0-kilogram box from the floor to a 0.92-meter high tabletop is equal to the box's change in gravitational potential energy.

$$W = \Delta PE = mg\Delta h = (10.0\text{ kg})(9.81\text{ m/s}^2)(0.92\text{ m}) = 90.\text{ J}$$

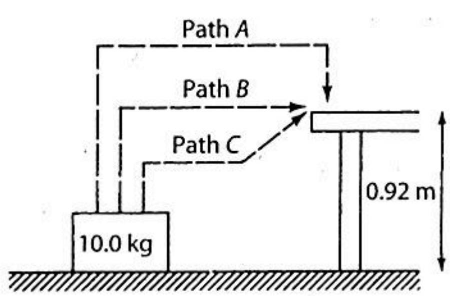


Figure 3-1. A conservative force: Because the force of gravity is a conservative force, the same amount of work is done when raising the box from the floor to the tabletop regardless of which path is followed.

Figure 3-1 shows that the work done in moving the box from the floor to the tabletop is the same regardless of the path taken. When work done against a force is independent of the path taken, the force is said to be a conservative force. The force of gravity is an example of a conservative force. The elastic force of a spring is also a conservative force. Potential energy has meaning only in relation to work done against conservative forces.

Air resistance and friction are examples of nonconservative forces. The work done against a nonconservative force is dependent upon the path taken. In Figure 3-2, the same box is moved from the floor to the tabletop by sliding it along an inclined plane A. Once again, 90. joules of work is done to change the gravitational potential energy of the box, but because additional work must be done against friction, the total work done is greater than 90. joules.

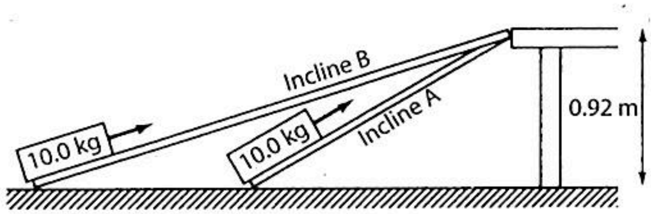


Figure 3-2. A nonconservative force: Because friction is a nonconservative force, moving the box from the floor to the tabletop requires more work on incline B than on incline A. In this case, the path makes a difference in the amount of work required. (Read the explanation in the text.)

If inclined plane B is used instead of inclined plane A, the work done against friction, $W_f = F_f d$, is greater, even though the coefficient of friction is the same for both planes. The force of friction F_f is greater when a plane is inclined at a smaller angle because the normal force F_N for the same object