Solutions to Period 6 Exercises

E.1 **The potential energy of a body near the Earth**

a) increases as the mass of the body increases.

b) is increased if the body is raised.

c) is increased when the body is dropped.

d) is decreased if the shape of the body is changed, but the center of mass remains in the same position.

e) is correctly described by both a. and b. above.

From the equation,

$$E_{pot} = M\ g\ h$$

the gravitational potential energy stored in a raised object is directly proportional to the height it is raised and to the mass of the object.

E.1 = e

E.2 **In which of the following cases is the most work done against the force of gravity on the object moved? (Neglect friction)**

a) A woman carries a 5 pound box of tools to the top of a building 600 feet high.

$W = M g h$ = 5 lbs x 600 ft = 3,000 ft-lbs

b) A hoist lifts a 4000 pound automobile vertically a distance of ½ of a foot.

$W = M g h$ = 4,000 lbs x 0.5 ft = 2,000 ft-lbs

c) Gravity acts on a 2 pound stone as it falls a distance of 200 feet.

In this case, the force of gravity does work on the stone. No work is done against the force of gravity.

d) A 200 pound man climbs a 10-foot flight of stairs.

$W = M g h$ = 200 lbs x 10 ft = 2,000 ft-lbs.

e) The work done in all cases is the same.

E.2 = a

E.3 **Robert is driving his car from Columbus to Cincinnati. While driving on the freeway, he maintains a steady speed of 50 miles per hour. After exiting from the freeway, he drives at a constant speed of 25 miles per hour. Relative to the kinetic energy of his car on the freeway, the kinetic energy of his car after exiting is**

a) two times as large.

b) one-half as large.

c) four times as large.

d) one-fourth as large.

e) the same.

Use the equation $E_{kin} = \frac{1}{2} M v^2$ and make a ratio of the two kinetic energies.

Off the freeway $E = \frac{\cancel{\frac{1}{2} M} (25)^2}{\cancel{\frac{1}{2} M} (50)^2} = (1/2)^2 = 1/4$

E.3 = d

E.4 Which has more kinetic energy, a 3,000 pound car moving at 75 MPH or an 18,000 pound truck moving at 25 MPH?

- **First,** convert the quantities into metric units. Use weight = F = Mg to find the mass.

Car: $3{,}000 \text{ lbs} \times \frac{4.45 \text{ N}}{1 \text{ lb}} = 13{,}350 \text{ N}$

$M = \frac{\text{Weight}}{g} = \frac{13{,}350 \text{ kg m/s}^2}{9.8 \text{ m/s}^2} = 1{,}362 \text{ kg}$

$v = \frac{75 \text{ miles}}{\text{hour}} \times \frac{1{,}609 \text{ m}}{1 \text{ mile}} \times \frac{1 \text{ hour}}{3{,}600 \text{ s}} = 33.5 \text{ m/s}$

- **Then** use $E_{kin} = \frac{1}{2} M v^2$

$E_{kin} = \frac{1}{2} (1{,}362 \text{ kg}) \times (33.5 \text{ m/s})^2 =$

$681 \text{ kg} \times 1122 \text{ m}^2/\text{s}^2 = 764{,}252 \text{ J} = 7.6 \times 10^5 \text{ J}$

Truck: The truck's weight is 6 times the car's weight (18,000 lbs/3,000 lbs = 6)

M = 6(car mass) = 6(1,362 kg) = 8,172 kg.

The truck's velocity is 1/3 of the car's velocity (25 mph/75 mph = 1/3)

v = 1/3(car velocity) = 1/3(33.5 m/s) = 11.2 m/s

$E_{kin} = \frac{1}{2} (8{,}172 \text{ kg}) \times (11.2 \text{ m/s})^2 =$

$4{,}086 \text{ kg} \times 125 \text{ m}^2/\text{s}^2 = 510{,}750 \text{ J} = 5.1 \times 10^5 \text{ J}$

E.4 = b

E.5 If a slide with a vertical height of 4 feet is totally frictionless, what speed would a person have at the bottom of the slide? (**Hint:** Ignoring friction, the gravitational potential energy at the top of the slide equals the kinetic energy at the bottom. The acceleration of gravity, g, in English units = 32 ft/s^2.)

a) 11 ft/s

b) 16 ft/s

c) 128 ft/s

d) 256 ft/s

e) You need to know the mass of the person to answer the question.

Gravitational pot. energy = $E_{pot} = M\ g\ h$

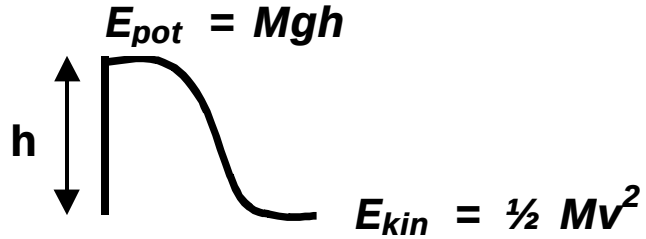
. Kinetic energy = $E_{kin} = \frac{1}{2}\ M\ v^2$

$\cancel{M}\ g\ h = \frac{1}{2}\ \cancel{M}\ v^2$

$2\ g\ h = v^2$ $\qquad \sqrt{2\ g\ h} = v$

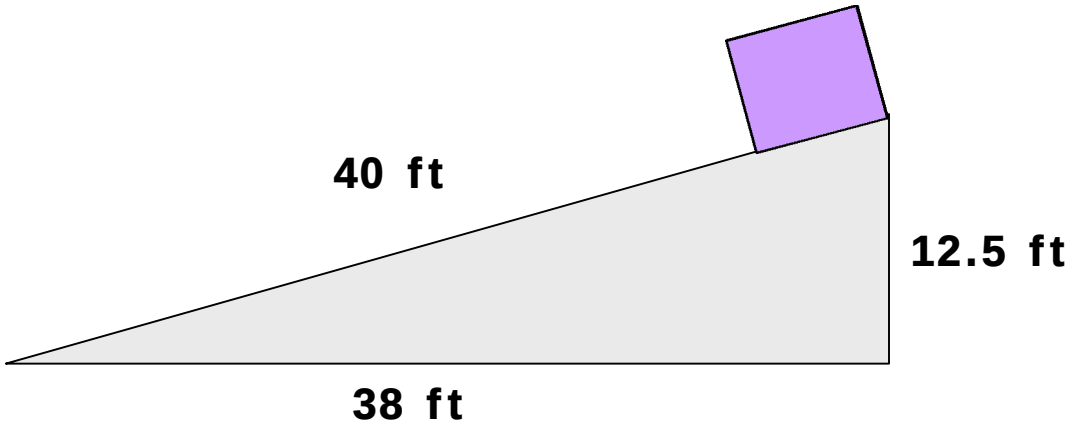
$$v = \sqrt{2 \text{ x } 32 \text{ ft/s}^2 \text{ x } 4\text{ft}} = \sqrt{256 \text{ ft}^2/\text{s}^2} = 16 \text{ ft/s}$$

If friction is ignored,



E.5 = b

E.6 **How much work must be done to push a 25 pound box to the top of the ramp? The force of friction between the box and the ramp is 10 pounds. The illustration shows the dimensions of the ramp.**



a) 88 ft-lbs

b) 692 ft-lbs

c) 712 ft-lbs

d) 3442 ft-lbs

e) 3462 ft-lbs

Work to raise 25 lbs to a height of 12.5 ft:

$W = M g h$ = 25 lbs x 12.5 ft = **312 ft-lbs**

Work to move the box against friction:

$W = F D$ = 10 lbs x 40 ft = 400 ft-lbs

Total = 312 ft-lbs + 400 ft-lbs = 712 ft-lbs

E.6 = c

Solutions to Period 6 Exercises

E.1 = e

E.2 = a

E.3 = d

E.4 = b

E.5 = b

E.6 = c