ENG1004: Engineering Physics 1

Energy and work
Additional Exercises

Question 1

A 200 g ball thrown vertically up with an initial speed of 20 m/s reaches a maximum height of 18 m. Find: (a) the change in its kinetic energy; (b) the work done by gravity. (c) Explain why the quantities are not equal.

Adapted from Benson, "University Physics", Revised Edition, John Wiley & Sons, inc., 1996.

Answer

(a) -40 J; (b) -35 J;

Question 2

A baseball is thrown from the roof of a 22.0 m tall building with an initial velocity of magnitude 12.0 m/s and directed at an angle of 53.1° above the horizontal. (a) What is the speed of the ball just before it strikes the ground? Use energy methods and ignore air resistance. (b) What is the answer for part (a) if the initial velocity is at an angle of 53.1° below the horizontal? (c) If the effects of air resistance are included, will part (a) or (b) give the higher speed?

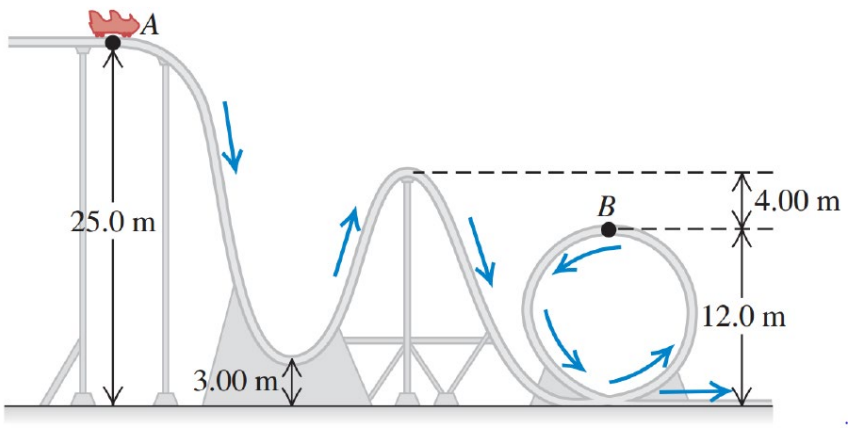
Adapted from Young and Freedman, "University Physics with Modern Physics", 14th Edition, Pearson, 2015.

Answer

(a) 24.0 m/s; (b) 24.0 m/s; (c) part (b)

Question 3

A 350 kg roller coaster starts from rest at point A and slides down the frictionless loop-the-loop shown in the figure. (a) How fast is this roller coaster moving at point B? (b) How hard does it press against the track at point B?



Adapted from Young and Freedman, "University Physics with Modern Physics", 14th Edition, Pearson, 2015.

Answer

(a) 16.0 m/s; (b) 1.15 x 10^4 N.

Question 4

You are testing a new amusement park roller coaster with an empty car of mass 120 kg. One part of the track is a vertical loop with radius 12.0 m. At the bottom of the loop (point A) the car has speed 25.0 m/s, and at the top of the loop (point B) it has speed 8.0 m/s. As the car rolls from point A to point B, how much work is done by friction?

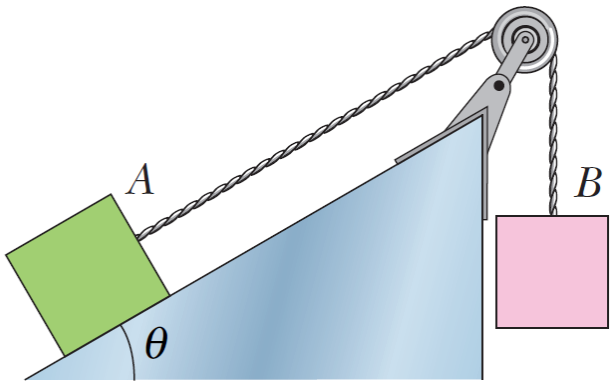
Adapted from Young and Freedman, "University Physics with Modern Physics", 14th Edition, Pearson, 2015.

Answer

-5500 J

Question 5

In the figure, the pulley has negligible mass, and both it and the inclined plane are frictionless. Block A has a mass of 1.0 kg, block B has a mass of 2.0 kg, and angle θ is 30°. If the blocks are released from rest with the connecting cord taut, what is their total kinetic energy when block B has fallen 25 cm?



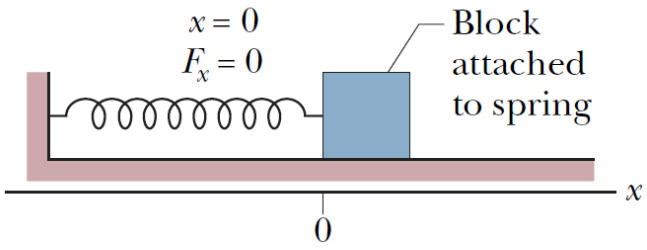
Adapted from Walker, "Halliday and Resnick Fundamentals of Physics", 9th Edition, John Wiley & Sons, Inc., 2011.

Answers

3.7 J

Question 6

A spring and block are in the arrangement shown below. When the block is pulled out to x = 4.0 cm, we must apply a force of magnitude 360 N to hold it there. We pull the block to x = 11 cm and then release it. How much work does the spring do on the block as the block moves from x_i = 5.0 cm to (a) x = 3.0 cm, (b) x = -3.0 cm, (c) x = -5.0 cm, and (d) x = -9.0 cm?



Adapted from Walker, "Halliday and Resnick Fundamentals of Physics", 9th Edition, John Wiley & Sons, Inc., 2011.

Answers

(a) 7.2 J; (b) 7.2 J; (c) 0; (d) - 25 J

Question 7

A spring of negligible mass has force constant k = 1600 N/m. (a) How far must the spring be compressed for 3.20 J of potential energy to be stored in it? (b) You place the spring vertically with one end on the floor. You then drop a 1.20 kg book onto it from a height of 0.800 m above the top of the spring. Find the maximum distance the spring will be compressed.

Adapted from Young and Freedman, "University Physics with Modern Physics", 14th Edition, Pearson, 2015.

Answer

(a) 6.32 cm; (b) 12 cm

Question 8

You are an industrial engineer with a shipping company. As part of the package-handling system, a small box with mass 1.60 kg is placed against a light spring that is compressed 0.280 m. The spring has force constant k = 45.0 N/m. The spring and box are released from rest, and the box travels along a horizontal surface for which the coefficient of kinetic friction with the box is μ_k = 0.300. When the box has travelled 0.280 m and the spring has reached its equilibrium length, the box loses contact with the spring. (a) What is the speed of the box at the instant when it leaves the spring?

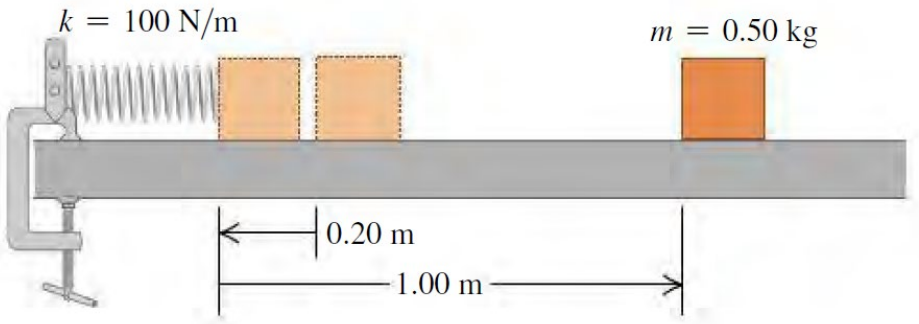
Adapted from Young and Freedman, "University Physics with Modern Physics", 14th Edition, Pearson, 2015.

Answers

(a) 0.747 m/s;

Question 9

A block with mass 0.50 kg is forced against a horizontal spring of negligible mass, compressing the spring a distance of 0.20 m. When released, the block moves on a horizontal tabletop for 1.00 m before coming to rest. The force constant k is 100 N/m. What is the coefficient of kinetic friction μ_k between the block and the tabletop?



Adapted from Young and Freedman, "University Physics with Modern Physics", 14th Edition, Pearson, 2015.

Answer

0.41