Physics 125.05 & 08   Thursday Oct. 30, 2008   Cooperative learning exercise (quiz #8)

Answers

1. A projectile of mass m = 0.85 kg is fired with horizontal velocity v_x=150 m/s and vertical velocity v_y = 200 m/s.

a. How much kinetic energy does the projectile have right after it is fired?

$K_0 = mv^2/2 = m(v_x^2 + v_y^2)/2 = 2.66 \times 10^4$ J

b. At the highest point of the trajectory (neglecting friction) what are v_x, v_y, and the kinetic energy of the projectile?

v_x = 150 m/s (unchanged), $v_y = 0$, $K_1 = 0.96 \times 10^4$ J

c. How much work did gravity do? How much potential energy did the projectile gain? The Work-Energy theorem says the total work on a particle is the change of its kinetic energy; the definition of potential energy ΔU is the negative of the work by a conservative force.

$W_{grav} = K_1 – K_0 = -1.70 \times 10^4$ J $\Delta U = -W_{grav} = 1.70 \times 10^4$ J

2. A spring powered gun gives a pellet (m = 0.025 kg) a muzzle velocity v = 75 m/s.

a. How much kinetic energy did the spring give to the pellet?

$K = mv^2/2 = 70.3$ J

b. How much potential energy was stored in the spring?

$U_{spring} = 70.3$ J

c. If the compression of the spring was x = 0.018 m, what is the spring constant k?

$kx^2/2 = U_{spring} \rightarrow k = 2U_{spring}/x^2 = 4.3 \times 10^5$ N/m

3. A ball (m = 0.044 kg) is dropped vertically from rest from a height h = 18 m.

a. How much kinetic energy does the ball have just before it strikes the floor?

$K_1 = -\Delta U_{grav} = mgh = 7.8$ J

b. How much work does the floor do during the first half of the elastic bounce, as the ball is brought to rest? Use the work-energy theorem!

$W_{floor,1} = 0 – K_1 = -7.8$ J This comes from a large, unknown upward force of the floor times a small downward displacement while the ball is being compressed.

c. How much work does the floor do during the second half of the elastic bounce, as the ball recovers its speed (but moves now in the upward, not the downward direction)?

$W_{floor,2} = K_1 - 0 = +7.8$ J Now the displacement is upward and the force is still upward.

d. Suppose the bounce is not elastic. If 2.0 J of energy is lost during the bounce, how high does the ball return to?

$K_3 = K_2 – 2.0\text{J} = 5.8 \text{ J} = mgh \rightarrow h = 13.4$ m