PHYSICS 1030
Homework #4

(Due Oct. 30, 2018, 11:59 pm)

1. The Web site *Today I Found Out* recently made the following claim: "A baseball thrown 90 mph has about the same kinetic energy as a .22 caliber bullet fired from a handgun." Verify this claim by finding (a) the kinetic energy of the baseball, and (b) the kinetic energy of the bullet. Are the two energies comparable? Use the following data: mass of a baseball = 145 grams; mass of a .22 bullet = 40 grains; .22 handgun bullet speed = 1045 ft/sec. (A *grain* is an English unit of mass: 7000 grains = 1 lbm.) *Hint:* Convert everything to a common set of units of your choice (SI, cgs, or English). Find the two kinetic energies in the same set of units.

2. Suppose one wishes to establish a space platform or satellite moving in a circle in the Earth's equatorial plane and at such a height above the Earth's surface that it remains always above the same point. Find the height of the space platform above the Earth's surface.

4. A block weighing 16 lb is pushed 20 ft along a horizontal frictionless surface by a horizontal force of 8 lb. The block starts from rest. (a) How much work is done? (b) Check your answer by computing the acceleration of the block, its final velocity, and its kinetic energy.

5. A block weighing 2 lb is forced against a horizontal spring of negligible mass, compressing the spring an amount $x_1 = 6$ inches. Upon releasing the block, it moves on a horizontal table top a distance $x_2 = 2$ ft before coming to rest. The spring constant k is 8 lb/ft. What is the coefficient of friction μ between the block and the table?

6. The projectile of a 16-in seacoast gun weighs 2400 lb, travels a distance of 38 ft in the bore of the gun, and has a muzzle velocity of 2250 ft/sec. The gun weighs 300,000 lb. (a) Compute the initial recoil velocity of the gun, assuming it free to recoil. (b) Find the ratio of the kinetic energy of the projectile to that of the recoiling gun.

7. A neutron of mass 1.67×10^{-24} g, moving with a velocity of 2×10^6 cm/s, makes a head-on collision with a boron nucleus of mass 17×10^{-24} g, originally at rest. (a) If the collision is completely inelastic, what is the final kinetic energy of the system, expressed as a fraction of the original kinetic energy? (b) If the collision is perfectly elastic, what fraction of its original kinetic energy does the neutron transfer to the boron nucleus?

8. (Serway 8-12) A sled of mass m is given a kick on a frozen pond. The kick imparts to the sled an initial speed of 2.00 m/s. The coefficient of kinetic friction between sled and ice is 0.100. Use energy considerations to find the distance the sled moves before it stops.

9. (Serway 9-2) An object has a kinetic energy of 275 J and a momentum of magnitude 25.0 kg m/s. Find the speed and mass of the object.

10. (Serway 9-11) Two blocks of masses m and $3m$ are placed on a frictionless, horizontal surface. A light spring is attached to the more massive block, and the blocks are pushed together with the spring between them (Fig. P9.11 in the text). A cord initially holding the blocks together is burned; after that happens, the block of mass $3m$ moves to the right with a speed of 2.00 m/s. (a) What is the velocity of the block of mass m? (b) Find the systems original elastic potential energy, taking $m = 0.350$ kg.

11. (Serway 9-26) Four railroad cars, each of mass 2.50×10^4 kg, are coupled together and coasting along horizontal tracks at speed v_i toward the south. A very strong but foolish movie actor, riding on the second car, uncouples the front car and gives it a big push, increasing its speed to 4.00 m/s southward. The remaining three cars continue moving south, now at 2.00 m/s. (a) Find the initial speed of the four cars. (b) How much work did the actor do?

12. (Serway 9-29) A tennis ball of mass 57.0 g is held just above a basketball of mass 590 g. With their centers vertically aligned, both are released from rest at the same time, to fall through a distance of 1.20 m, as shown in Figure P9.29 of the text. (a) Find the magnitude of the downward velocity with which the basketball reaches the ground. (b) Assume that an elastic collision with the ground instantaneously reverses the velocity of the basketball while the tennis ball is still moving down. Next, the two balls meet in an elastic collision. To what height does the tennis ball rebound?

13. (Serway 9-31) A 12.0-g wad of sticky clay is hurled horizontally at a 100-g wooden block initially at rest on a horizontal surface. The clay sticks to the block. After impact, the block slides 7.50 m before coming to rest. If the coefficient of friction between the block and the surface is 0.650, what was the speed of the clay immediately before impact?