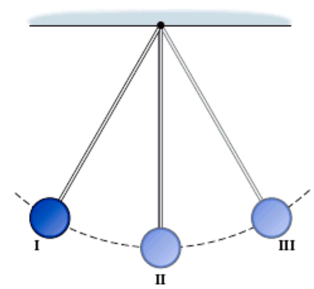
**Physics 100A – Summer 2016**
**<u>Chapter 7</u>**

Solutions are provided only for problems from your textbook. The other problems already have so much guidance and notes that you should be able to understand where you have gone wrong.

**Problems**

**3. Picture the Problem**: A pendulum bob swings from point II to point III along the circular arc indicated in the figure at right.



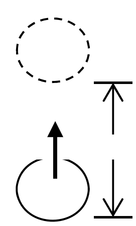

**Strategy:** Apply equation 7-3, which says that the work done on an object is positive if the force and the displacement are along the same direction, but zero if the force is perpendicular to the displacement.

**Solution: 1. (a)** As the pendulum bob swings from point II to point III, the force of gravity points downward and a component of the displacement is upward. Therefore, the work done on the bob by gravity is $\boxed{\text{negative}}$.

**2. (b)** As the pendulum bob swings, the force exerted by the string is radial (toward the pivot point) but the displacement is tangential, perpendicular to the force. We conclude that the work done on the bob by the string is $\boxed{\text{zero}}$.

**Insight:** The work done by the Earth is positive if the bob swings from point I to point II because a component of the displacement is downward and the force is downward.

**6. Picture the Problem**: The pumpkin is lifted vertically then carried horizontally.



**Strategy:** Multiply the force by the distance because during the lift the two point along the same direction.

**Solution: 1. (a)** Apply equation 7-1 directly:

$$W = mgd$$
$$= (3.2\text{ kg})(9.81\text{ m/s}^2)(1.2\text{ m}) =$$

**2. (b)** The force is perpendicular to the displacement so $W = \boxed{0}$.

**Insight:** You can still get tired carrying a pumpkin horizontally even though you're doing no work!

**19. Picture the Problem**: The runner accelerates horizontally and runs in a straight line.

**Strategy:** The work done equals the change in kinetic energy.

**Solution:** Find the change in kinetic energy:

$$W = \Delta K = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 = \tfrac{1}{2}(73\text{ kg})\left[(7.7\text{ m/s})^2 - 0\right] = 2200\text{ J}$$

**Insight:** The runner's kinetic energy comes from the forces his muscles exert on his center of mass over the distance which his center of mass moves.

**23. Picture the Problem**: Four joggers have a variety of masses and speeds.

**Strategy:** Use the definition of kinetic energy to determine the relative magnitudes of the kinetic energies.

**Solution: 1.** Calculate the kinetic energies of each jogger.

**2.** $K_A = \tfrac{1}{2}(m)(v)^2 = \tfrac{1}{2}mv^2$

**3.** $K_B = \tfrac{1}{2}\left(\tfrac{1}{2}m\right)(3v)^2 = \tfrac{9}{2}\left(\tfrac{1}{2}mv^2\right)$

**4.** $K_C = \tfrac{1}{2}(3m)\left(\tfrac{1}{2}v\right)^2 = \tfrac{3}{4}\left(\tfrac{1}{2}mv^2\right)$

**5.** $K_D = \tfrac{1}{2}(4m)\left(\tfrac{1}{2}v\right)^2 = \tfrac{1}{2}mv^2$

**6.** By comparing the magnitudes of the kinetic energies we arrive at the ranking $\boxed{C < A = D < B}$.

**Insight:** Even with three times the mass of jogger A, jogger C has only three-fourths the kinetic energy because the kinetic energy is proportional to the square of the speed.

**25. Picture the Problem:** The pine cone falls straight down for 16 m under the influence of gravity**.**

**Strategy:** The work done by air resistance is the difference in kinetic energies between the air resistance and no air resistance cases. The work done by gravity is always W = mgh (see Example 7-2 and Conceptual Checkpoint 7-1).

**Solution: 1. (a)** Find the difference in kinetic energies between the air resistance and no air resistance cases:

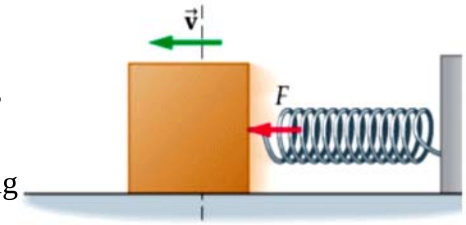
$$W = \Delta K = K_f - K_i = \tfrac{1}{2}mv_f^2 - mgh$$
$$= (0.140\text{ kg})\left[\tfrac{1}{2}(13\text{ m/s})^2 - (9.81\text{ m/s}^2)(16\text{ m})\right] = \boxed{-10\text{ J}}$$

**2. (b)** The work done by air resistance equals the average force of air resistance times the distance the pine cone falls. It is negative because the upward force is opposite to the downward distance traveled.

$$W = -Fd \quad \text{so that} \quad F = -\frac{W}{d} = -\frac{(-10\text{ J})}{16\text{ m}} = \boxed{0.63\text{ N upward}}$$

**Insight:** Kinetic friction always does negative work because the force is always opposite to the direction of motion.

**33. Picture the Problem**: The compressed spring pushes the block from rest horizontally on a frictionless surface. The block slides to the left as indicated in the figure.




**Strategy:** The work to stretch or compress a spring a distance $x$ is $\frac{1}{2}kx^2$. The work done by the spring equals the kinetic energy gained by the block.

**Solution: 1.** Apply equations 7-7 and 7-8: $W = \frac{1}{2}kx^2 = \Delta K = \frac{1}{2}mv_f^2 - 0$

**2.** Now solve for $v_f$: $$v_f = \left(\sqrt{\frac{k}{m}}\right)x = \left(\sqrt{\frac{1.0\times10^4 \text{ N/m}}{1.2 \text{ kg}}}\right)(0.15 \text{ m}) = \boxed{14 \text{ m/s}}$$

**Insight:** The work done on the spring in order to compress it becomes stored potential energy. That stored energy becomes the kinetic energy of the block as the spring accelerates it.

**46. Picture the Problem**: The microwave oven delivers energy to the ice cube via electromagnetic waves.

**Strategy:** The power required is the energy delivered divided by the time.

**Solution:** Solve equation 7-10 for $t$: $$t = \frac{W}{P} = \frac{32200 \text{ J}}{105 \text{ W}} = 307 \text{ s} = \boxed{5.11 \text{ min}}$$

**Insight:** Power can be regarded as the rate of energy transfer because work is essentially transferred energy. We'll learn more about melting ice cubes in Chapter 17 and electromagnetic waves in Chapter 25.