Moving through a liquid, an object of mass $m$ experiences a resistive drag force proportional to its velocity, $F_{\text{drag}} = -bv$, where $b$ is a constant. (a) Find an expression for the object’s speed as a function of time, when it starts from rest and falls vertically through the liquid. (b) Show that it reaches a terminal velocity $mg/b$. 

Note typo in book.
EX

The potential energy function for the force between two atoms in a diatomic molecule can be expressed as (approximately):

\[ U(x) = \frac{a}{x^{12}} - \frac{b}{x^6} \]

where \( x \) is the distance between atoms and \( a \) and \( b \) are positive constants.

1. At what values of \( x \) is \( U(x) = 0 \)? When is \( U(x) \) a minimum? [Hint: Might be helpful to try part E first!]

2. Determine the force between atoms. [\( F(x) \)]

3. Assume that one of the atoms remains at rest and that the other moves along \( x \). Describe possible motions. [Hint: See hint to part a]

4. The energy needed to break up the molecule into separate atoms is called the dissociation energy. What is the dissociation energy of the molecule?

5. Sketch \( U(x) \) and \( F(x) \). Provide as much detail as possible.
Ex 7 Two point masses collide elastically. One mass \( (m_2) \) was initially at rest. The other mass \( (m_1) \) is scattered off at angle \( \theta \). What fraction of its initial energy does \( m_1 \) have after the collision?

Note: this problem is closely related to Wolfson ch. 9 #73 as well as Ex. 9.11.
Your alpine rescue team is using a slingshot to send an emergency medical packet to climbers stranded on a ledge, as shown in Fig. 3.26; your job is to calculate the launch speed. What do you report?
Spring is stretched out 3.0 in from equilibrium by a force of 0.75 lb. A mass of 1.5 lb is then attached to the spring and stretched 4.0 in. from equilibrium. When released, the mass undergoes simple harmonic motion.

a) What is the force constant of the spring?

b) What is the force exerted by the spring on the mass just before it is released?

c) What is the period of oscillation after release?

d) What is the amplitude of oscillation?

e) What is the maximum speed of the mass?

f) What is the maximum acceleration of the mass?

g) Once the block has moved halfway from its initial position to its center of motion, determine the following (at that point): velocity, acceleration, kinetic energy, and potential energy.

h) Compute the total energy of the oscillating system.

i) What is the displacement of the mass as a function of time?
Ex

Determine the volume of a cone of height \( H \) and base radius \( R \). Also determine its center of mass, assuming the cone has uniform density \( \rho \).
You’re a consulting engineer specializing in athletic facilities, and you’ve been asked to help design the Olympic ski jump pictured in Fig. 3.27. Skiers will leave the jump at 28 m/s and 9.5° below the horizontal, and land 55 m horizontally from the end of the jump. Your job is to specify the slope of the ground so skiers’ trajectories make an angle of only 3.0° with the ground on landing, ensuring their safety. What slope do you specify?