

## PHYSICS 180

### Problem set #7

due: November 8, 2006

*“Common sense is the accumulation of prejudices acquired by age 18.”*

A. Einstein (1879-1955)

- 1) i) A chain with mass per unit length of  $\mu$  rests on the floor. At time  $t = 0$  Rezwana pulls the end of the chain up vertically with a constant speed  $v$ . What is the force that she must apply at any time to do this?  
  
ii) A chain of length  $L$ , and mass per unit length of  $\mu$ , is held at rest by Josh on a frictionless table with a quarter of its length hanging over the edge. After he releases the chain what is its speed the moment it is completely off the table?
- 2) A machine gun is attached at one end of a 10 m long stationary flatcar and fires towards the other end. Determine the average recoil force on the gun if it fires 240 rounds per minute, the mass of the bullets is 25 g, and the muzzle velocity is 900 m/s. If each bullet is in the 0.5 m long barrel for  $2 \times 10^{-3}$  s after discharge, estimate the peak force on the gun. If the bullets are absorbed by a target at the other end, and the  $10^3$  kg flatcar moves without friction, how fast and in what direction does the flatcar move?
- 3) The potential energy between two atoms is often described by  $U(r) = -\alpha / r^n + \beta / r^2$ . Determine the equilibrium separation between the atoms in terms of  $\alpha$ ,  $\beta$  and  $n$ . Show that the equilibrium is stable only if  $n < 2$ . Sketch the form of the potential for  $\alpha = 2\beta$  and  $n = 1$ .
- 4) A rocket of mass  $10^4$  kg is to be launched vertically. The burn rate is 20 kg/s. What is the minimum exhaust velocity required to lift the rocket off the Earth? If one neglects gravity, determine the final speed of the rocket/payload if it burns its entire fuel load of 9000 kg which is ejected with the minimum exhaust velocity. How does your answer change if the fuel mass is 9900 kg?

Also look at Serway, Ch. 9: probs. 8, 9, 10, 13, 17, 20, 22, 28, 36, 39, 41, 47, 51, 57, 64, 67, 72

(No problem set next week. Second term test is on Thursday, Nov. 16.)