

Mechanics and Special Relativity, Spring 2006

Homework Assignment # 5

(Due Wednesday, March 8, before the lecture.)

Lectures and Reading Assignments:

Readings are from “*An Introduction to Mechanics*” by Kleppner and Kolenkow.

- Lec 18, 3/3 (Fri): Momentum Transport. **Sec. 3.6 (pp. 139–145).**
- Lec 19, 3/6 (Mon): Work-Energy Theorem in 1D. **Sec. 4.1–4.3 (pp. 152–157).**
- Lec 20, 3/8 (Wed): Work-Energy Theorem in 3D. **Sec. 4.4–4.6 (pp. 158–168).**

Problems:

Numbered problems are from “*An Introduction to Mechanics*” by Kleppner and Kolenkow, Chapter 3 (pp. 147–149).

1. A very long vertical cylinder is filled with gas. The density of the gas varies as $\rho(y) = \rho e^{-\alpha y}$, where y is the distance from the bottom of the cylinder. Neglecting the mass of the cylinder’s walls, find the position of the center of mass of the system.
2. Problem 3.3
3. Problem 3.7
4. Problem 3.13
5. A rocket is travelling in empty space with a velocity of 500 m/sec, with its engines turned off. The mass of the rocket with fuel is 10000 kg. The captain decides to change the direction of the motion. To do that, he turns the nozzle of the rocket so that it is perpendicular to the original direction of the motion, and turns the engine on for a brief period of time. The velocity at which the gas is expelled from the nozzle is 100 m/sec. How much fuel will need to be spent to deflect the rocket by $\pi/6$ from the original trajectory?
6. Problem 3.18