

**PHYS 721 – HOMEWORK # 2 – DUE THURSDAY, SEPTEMBER 14, 2017**

**Problem 1.** Use the conservation of the stress-energy momentum tensor,  $\partial_\alpha T^{\alpha\beta} = 0$ , where  $T^{\alpha\beta} = p\eta^{\alpha\beta} + (p + \rho)U^\alpha U^\beta$  and  $U^\alpha$  is the velocity four-vector, and the conservation of the number density,  $\partial_\alpha N^\alpha = 0$ , where  $N^\alpha = nU^\alpha$ , to show that the specific entropy of a perfect fluid is constant in time:

$$pd\left(\frac{1}{n}\right) + d\left(\frac{\rho}{n}\right) = kTd\sigma = 0,$$

where  $\rho$  is the energy density,  $p$  the pressure,  $n$  is the number density,  $\sigma$  is the specific entropy,  $T$  is the temperature, and  $k$  is Boltzmann's constant. **Show all the steps of the derivation, please!**

**Problem 2.** Carroll problem 1.9

**Problem 3.** Carroll problem 1.10