Physics 3041 (Spring 2021) Homework Set 4 **(Due 2/24)**

1. (a) Problem 8.1.1. (5 points)

(b) Problem 8.1.2, and find the expression of θ in terms of the relative velocity. (10 points)

(c) Problem 8.2.4, for Lorentz transformation only. (5 points)

2. (a) Problem 8.3.4, but using Cramer's rule to solve the first set of equations only. (5 points)

(b) Problem 8.3.5. (5 points)

3. (a) Problem 8.4.3. (5 points)

(b) Problem 8.4.19, proving the first result only. (5 points)

(c) Problem 8.4.20. (10 points)

4. (a) Problem 8.4.5. (10 points)

(b) Problem 8.4.8. (10 points)

(c) Problem 8.4.10. (5 points)

5. Problem 8.4.17. (5 points)

6. (a) Consider a horizontal spring-mass system. The spring has a spring constant k and is fixed at one end. The other end is attached to a block of mass m that can move without friction on a horizontal surface. The spring is stretched a length a beyond its rest length and let go. Without solving the problem using Newton's second law, find the angular frequency of oscillations and show that it is independent of a. (5 points)

(b) Derive the Planck mass, length, and time in terms of Planck's constant $\hbar$, Newton's constant G, and speed of light c. Evaluate these quantities in SI units. (10 points)

(c) Identify the relevant physical quantities and use dimensional analysis to find the characteristic length for a black hole of mass M. (5 points)