

Problem Set III: Due Thursday, February 12, 2015

- 1.) Fetter and Walecka 6.6
- 2.) Fetter and Walecka 6.7
- 3.) Fetter and Walecka 6.8
- 4.) Fetter and Walecka 6.17
- 5.)
 - a.) Derive the generating function and transformation rules for a “momentum change of variables” where $P = g(p)$, and g is a given function. Show directly that phase volume is conserved.
 - b.) Show that if a canonical transformation takes $p, q \rightarrow P, Q$, then $\frac{dP}{dt} = \frac{-\partial H'}{\partial Q}$, where H' is the new Hamiltonian.
- 6.) Find the frequencies of a three-dimensional harmonic oscillator with un-equal force constants, using the method of action-angle variables.
- 7.) Use a reduced form of the variational Principle discussed in class to show that Action is an adiabatic invariant for an oscillator with slowly varying parameter. Discuss the connection of this exercise to the WKB calculation discussed in class.
- 8.) What is the relation between the volume and pressure of a gas of point particles moving within a cubic box of side L ? Assume the walls are hard, so particles reflect elastically, and that two opposite sides move together or apart *slowly*. Comment on the relation between your result and those of thermodynamics.

- 9.) N.B.: i.) *Highly* recommended as preparation for midterm.
ii.) For those who are puzzled at this sort of assignment, see: “The Innovators”, by Walter Isaacson; location 1626 re: Grace Hopper.

In the course so far, we have discussed *four* types of multiple time scale approximation methods in mechanics. Give a concise summary of these. Include a table. Your summary should include:

- a listing of the disparate time scales
- the approximation made
- why it works – what is the leverage
- any key features – i.e. resonances, etc.
- the ‘canonical example’ for each
- a line summary of the bottom line for the canonical example