CHGN 351
MIDTERM CONCEPTS

Rather than give a practice exam, listed here are the concepts from which exam questions will be drawn. If you fully understand, and are able to explain the following concepts, you will do well on the exam.

1) Explain why the mathematical statement of the First Law of Thermodynamics, \( \Delta E = Q + W \), implies that energy is conserved.

2) Explain what is meant by “Degrees of Mechanical Freedom.” Use a diatomic gas as a specific example.

3) Imagine that the temperature of a vessel holding a diatomic gas is increased, describe how the motion of the molecules will change.

4) Explain why there is a relationship between the number of degrees of freedom of a molecular gas and its heat capacity.

5) In what way did the classical predictions for the heat capacity of a diatomic gas differ from the measured values? Why? Give other examples where classical predictions were different from observation.

6) What does it mean to say that a particle moves under the influence of a potential?

7) Describe the motion of a particle moving in the potential \( V(x) = x^4 \).

8) Carefully and completely describe the steps you would take to discover the quantum mechanically allowed motions for the particle of problem 7. Be complete.

9) Provide a rough drawing of the first two wavefunctions for the particle of problem 7.

10) What does it mean to say that all the wavefunctions of a system form a complete set? Use Postulates 3 and 5 to explain why this must be the case.

11) What does it mean physically for two operators to commute? What does it mean mathematically?

12) For a particle moving in a straight line under the influence of a constant potential: Are its position and momentum independent? Are its momentum and velocity independent?

13) For a diatomic gas, are its translational and rotational degrees of freedom independent? Under what conditions would its rotational and vibrational degrees of freedom be independent?