1. If the wavelength of light is 400 nm, the energy associated with it is
   a. 119 kJ/mol  b. 400 kJ/mol  c. 200 kJ/mol  d. 299 kJ/mol
2. The number of vibrational degrees of freedom for HCN molecule are
   a. 1  b. 2  c. 3  d. 4
3. The number of rotational degrees of freedom for H₂O are
   a. 0  b. 1  c. 2  d. 3
4. The number of vibrations of OCO that are infrared active are
   a. 1  b. 2  c. 3  d. 4
5. The fundamental vibrational frequency of a molecule is 1.678x10^{13} Hz. The energy of the second vibrational level of this molecule is
   a. 5.559x10^{-21} J  b. 1.6678x10^{-20} J  c. 2.7797x10^{-20} J  d. 2980 J  e. none of these
6. The number of NMR signals expected for 1,4, 6-trimethyl benzene are
   a. 5  b. 10  c. 2  d. 6
7. The vibrational frequencies of HBr and DBr are related as
   a. Hbr > DBr  b. HBr = DBr  c. Hbr < DBr
8. Calculate the frequency of light of wavelength 350 nm.

9. The fundamental vibrational frequency of molecule A-A is 1.7x10^{13}s^{-1}. If mass of element A is 34.96885 g/mol, the force constant is
   a. 32.274 N/m  b. 332.47N/m  c. 300 N/m  d. 331.2N/m
10. Write the energy changes accompanying a molecule undergoing rotational-vibrational transitions, using the vibrational and rotational quantum numbers (v, J).
11. Sketch two vibrational modes of OCO.
12. The boiling points of H₂O, NH₃ and HF are related as
    a. H₂O>NH₃>HF  b. NH₃>H₂O>HF  c. HF>NH₃>H₂O  d. H₂O>HF> NH₃  e. none of these
13. Define: rate of a reaction; order of a reaction, molecularity of a reaction, elementary step, and the rate constant.
14. Starting from the rate expression for the first order reaction, rate = k Cₐ, where k is the rate constant, and Cₐ is the concentration of reagent A, derive the integrated rate expression.
15. Write the differential form of the rate expression for the second order reaction and integrate it.
16. Plot concentration vs time, for a first order reaction. Indicate the quantities for the slope and the intercept.
17. Show that the half life of a first order reaction is independent of initial concentration.
18. Show that the half life of the second order reaction depends on the initial concentration.
19. Write Arrhenius equation for the temperature dependence of the rate constant of a reaction. Explain the terms.

20. Draw enthalpy change for a reaction as a function of the reaction coordinate.

21. Write the simple expression for the rate of a bimolecular reaction, according to the Collision theory.

22. Draw a picture showing the activation enthalpy of a chemical reaction and its relation to the enthalpies of the reactants, as well as the products.