CHEM442-001/002
College of Charleston
Spring 2000
Exam V

1(30). Consider a hypothetical system consisting of energy states defined by the quantum numbers α and β.

A) The system consists of three energy states designated by the quantum numbers $\alpha = 1, 2,$ and 3 where the energy of each of these states is given by

$$E_\alpha = (10)\alpha^2$$

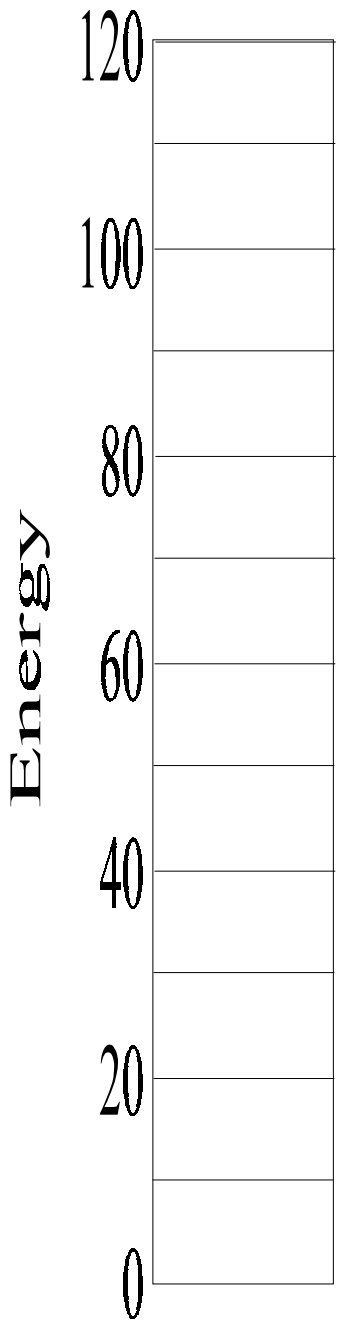
Construct an energy diagram (to scale) showing these states on the space provided on the next page. Label carefully.

B) In addition to the α energy states, there are additional energy states designated by the quantum number $\beta = 0, 1, 2, ..., \pm\alpha$ for each α state and the energy of each of these states is given by

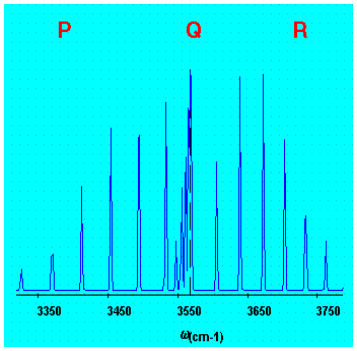
$$E_\beta = (3)\beta$$

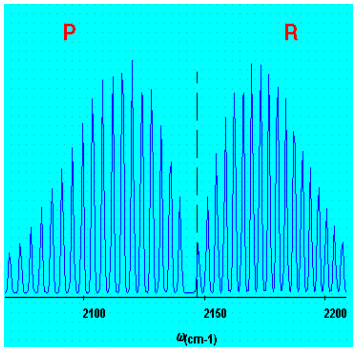
Complete the energy diagram (to scale) showing these states. Label carefully.

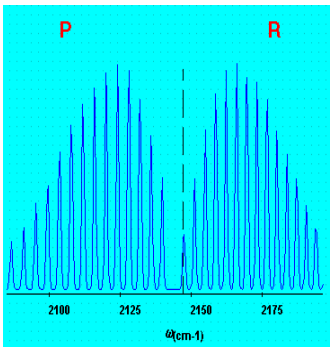
C) If the selection rules for transitions are $\Delta\alpha = \pm 2$ and $\Delta\beta = 0, \pm 2$, draw vertical lines between the energy states in your diagram illustrating the permitted transitions. How many lines will be observed? _____


Energy
120
100
80
60
40
20
0

2(10). Two of the following rotational-vibrational spectra are for the same compound at two different temperatures and one is for a second compound having a greater value of B_e.



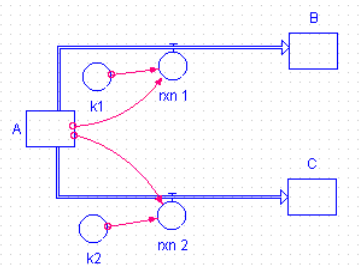


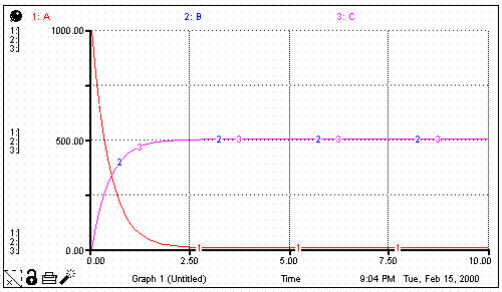


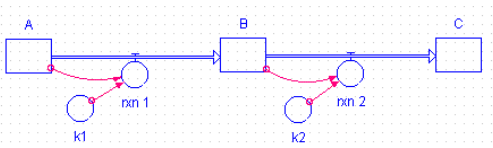
Draw a circle around the spectrum for the compound having the greater value of B_e and draw a box around the spectrum for the low temperature system.

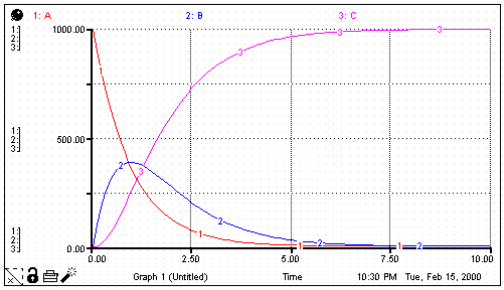
3(20). The rotational spectrum of PbS(g) consists of a series of evenly spaced lines separated by 0.23266 cm^{-1}. Calculate the bond length in this molecule.

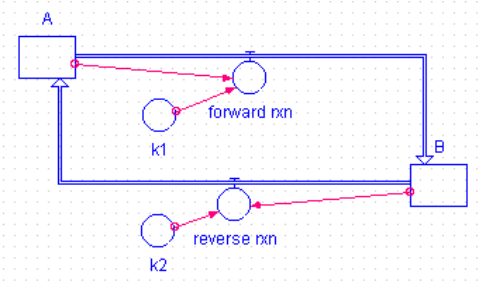
4(20). The following Stella models all involve the substance B. The plots shown to the right are for an initial number of A molecules equal to 1000 and for all rate constants equal to 1. Redraw the graphs if the rate constant *for the formation of B* ***only*** is changed to 2. Be sure to clearly label the curves for A, B, C, etc.

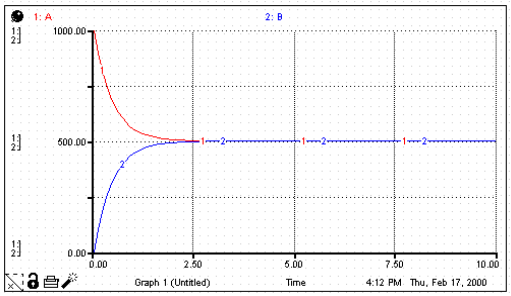












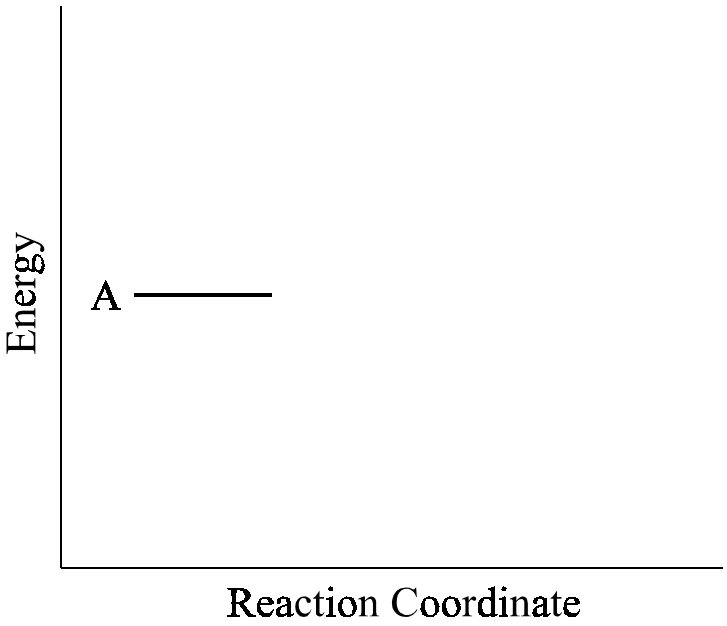
5(20). For the chemical reaction

$$2\ A \rightarrow B \qquad \Delta_r E = -150\ \text{kJ}$$

the rate constant doubles as the temperature increases from 23 ^{o}C to 33 ^{o}C.

A) Calculate the energy of activation for this reaction.

B) Complete the reaction coordinate diagram for this reaction clearly showing products, activation energy, and thermodynamic internal energy change.


Energy
A
Reaction Coordinate