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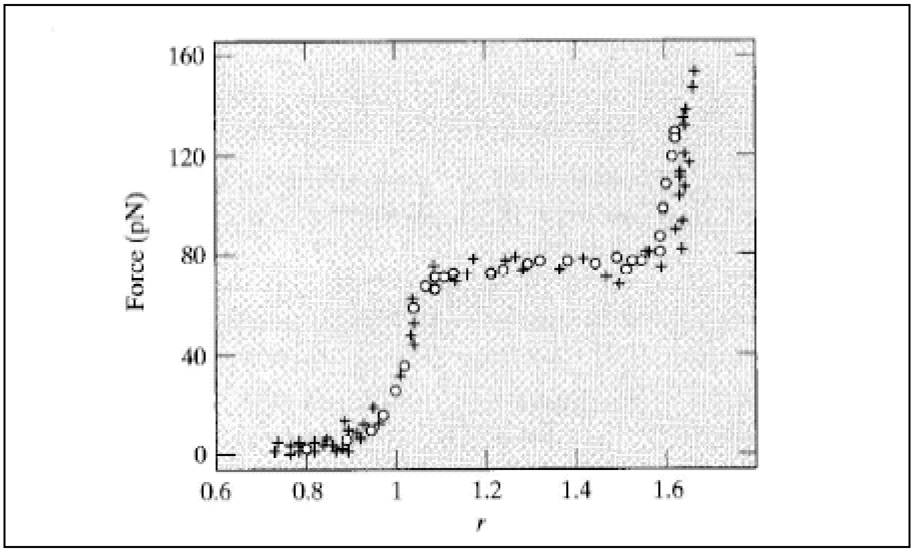
Recitation #2
9/15/2005

1. Systems: Seltzer water demo

2. *(from Tinoco et al, Physical Chemistry, 4th Ed, Ex 2.1)* Measurements with single DNA molecules in aqueous solution gave the data in the figure:



In this experiment, the DNA used was that of a virus called λ. (P. Cluzel, A. Lebrun, C. Heller, R. Lavery, J.-L. Vivoy, D. Chatenay, and F. Caron, 1996. DNA: an extensible molecule. Science, 271, 792-794). One end of a double stranded λ DNA, which has about 50,000 base pairs, was attached to an optical fiber, which would bend when pulled and served as a force sensor; the other end of the DNA was attached to a device termed a piezo translator which would move the attached DNA end by a distance in proportion of the voltage applied to the device. The measured force, in pN, is shown in the figure as a function of *r*, the distance between the ends of a DNA molecule, divided by the contour length of the DNA. A ratio *r* of 1.00 corresponds to an actual end-to-end separation of about 15 μm, the countour length l_0 of an unstretched λ DNA.

When the force is zero, the separation between the ends is less than l_0, as the unperturbed DNA molecule is coiled up rather than extended. The DNA extends readily to its contour length ($r = 1$) by the application of a small force, and thereafter the force rises more rapidly until a plateau is reached around 80 pN. The presence of this plateau suggests a tension-induced structural transition of the DNA, the length of which can be increased by at least 60% from that of the well-known Watson-Crick B-form of DNA. Stretching beyond an *r* of 1.7 leads to irreversible changes in the DNA.

Calculate the total work done on (a) a single λ DNA molecule when it is stretched from $r = 1$ to $r = 1.6$ and (b) 1 mole of λ DNA molecules.