3. Which of the following atoms/molecules would have greater rotational energy in the J=1 state? Please circle and briefly explain. (assume all are in the gas phase)

N_2 S_2 I_2 Xe He

$\varepsilon = \frac{\hbar^2}{2I} J(J+1)$

$I = \mu r^2$

5

as the μ increases for the atoms/molecules the rotational energy decreases as shown in the equation above, the inertia is in the denominator (invers relationship)

μ for $I_2 = \frac{(127)^2}{254} = 63$ heaviest.

backwards

4. Consider the following two systems. Which one is at the higher temperature? Explain. (Assume that the energy spacing between energy level 0 and energy level 1 is the same for both systems).

Continue $e^{\frac{346.1}{T}} = 1$

1.3×10^{-23}.

$e^{\frac{346.1}{T}} = \frac{1}{2}$

Second system should have higher temp. to get $\frac{1}{2}$

$\sqrt[T]{e^{346}} = 1$ $\sqrt[T]{e^{346.1}} = \frac{1}{2}$ T

Energy Level 1 xxxxxx xxx xxx

Energy Level 0 xxxxxx xxxxxx

System A **System B**

$T \to \infty$

$T < \infty$

$\frac{N_1}{N_0} = \frac{g_1}{g_0} e^{\frac{\Delta\varepsilon}{\infty}}$ $e^{\frac{1}{\infty}} = e^0 = 1$

if $T = \infty$ then $\frac{2}{3}$ of mol. should be in E_1 and $\frac{1}{3}$ in E_0. And that is not shown here.

$\frac{N_i}{N_j} = \frac{g_i}{g_j}$ $\frac{N_1}{N_2} = \frac{2}{1}$ 1/2 mole in E_1 1/2 mole in E_0 $\frac{N_i}{N_j} = \frac{g_i}{g_j} e^{\frac{-\Delta\varepsilon}{kT}}$

$\frac{6}{6} = \frac{1}{1} = e^{\frac{-(\Delta\varepsilon)}{kT}}$ $\frac{6}{6} = \frac{2}{1} = e^{-(\Delta\varepsilon)/kT}$

$-4.5 \times 10^{-21}/kT$

$1 = e$ $2 = e^{-(4.5 \times 10^{-21})/kT}$

? Where did this 4 come from

$1 = \frac{1}{e^{\frac{4.5 \times 10^{-21}}{kT}}}$ $2 = \frac{1}{e^{\frac{4.5 \times 10^{-21}}{kT}}}$

if T increases ratio decrease

$1 = \frac{1}{e^{346.1/T}}$ $2 = \frac{1}{e^{346.1/T}}$