مسائل بخش اول
۹۹۰۱۱۸

دانشجویان گرامی لطفا تا تاریخ ۹۹۰۲۰۱
جوابها را از طریق سامانه ارسال کنید.

PROBLEMS

(Useful constants: $N = 6{\cdot}023 \times 10^{23}$ mol^{-1}; $k = 1{\cdot}381 \times 10^{-23}$ J K^{-1}; $h = 6{\cdot}626 \times 10^{-34}$ J s; $c = 2{\cdot}998 \times 10^{8}$ m s^{-1}.)

1.1 The wavelength of the radiation absorbed during a particular spectroscopic transition is observed to be 10 μm. Express this in frequency (Hz) and in wavenumber (cm^{-1}), and calculate the energy change during the transition in both joules per molecule and joules per mole. If the energy change were twice as large, what would be the wavelength of the corresponding radiation?

1.2 Which of the following molecules would show (*a*) a microwave (rotational) spectrum, (*b*) an infra-red (vibrational) spectrum: Br_2, HBr, CS_2?

1.3 A particular molecule is known to undergo spectroscopic transitions between the ground state and two excited states, (*a*) and (*b*), its lifetime in (*a*) being about 10 s, and in (*b*) about 0·1 s. Calculate the approximate uncertainty in the excited state energy levels and the widths of the associated spectral 'lines' in hertz.

1.4 A certain transition involves an energy change of $4{\cdot}005 \times 10^{-22}$ J molecule^{-1}. If there are 1000 molecules in the ground state, what is the approximate equilibrium population of the excited state at temperatures of (*a*) 29 K, (*b*) 145 K, (*c*) 290 K and (*d*) 2900 K? What would your answer have been if the energy change were 10 times greater?

1.5 Calculate in hertz the broadening $\Delta\nu$ of transitions in HCN at 25 °C due to the Doppler effect in regions of the spectrum typical of rotational transitions (10 cm^{-1}), vibrational transitions (1500 cm^{-1}) and electronic transitions (60 000 cm^{-1}).

1.6 As a function of frequency, the spectral radiation density is given by

$$\rho(\nu) = \frac{8\pi h\nu^3}{c^3} \frac{1}{\exp(h\nu/kT) - 1}$$

Calculate typical values in the microwave ($\nu = 50$ GHz) and near-ultraviolet ($\tilde{\nu} = 30\,000$ cm^{-1}) regions.