Physical Chemistry Cumulative Exam

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(1) (10 points) Hotter blackbodies emit energy at all wavelengths.

When they are hotter, the peaks of the radiation curve is at _____ wavelengths.

A. shorter B. longer C. the same

When they are hotter, the intensity of the energy at long wavelength (>2000nm) is _____ .

A. stronger B. weaker C. the same

(20 points) If a spherical blackbody has radius 12cm and is at Kevin temperature T. At a distance of 100nm from the blackbody, the intensity of the electromagnetic radiation emitted by it (including all wavelengths) is measured to be 2.71 W/cm^2. Please calculate the value of T, and the value of the wavelength corresponding to the peak of the spectral radiancy curve. (Stefan–Boltzmann constant: 5.67×10^{-8} $W/m^2 K^4$, Wien displacement law constant: 2.898×10^6 nm K).

(2) (20 points) Explain Fluorescence and Phosphoresence processes. What's the time scales for each processes?

(3) (50 points) We can consider Rayleigh scattering is a process in which electromagnetic radiation (including light) is scattered by moving molecules, such as vibrations. If we use $E = E_0 \cos \omega t$. as the light wave (use long wavelength approximation), and use $(R-R_e) = A\cos\omega_{vib}t$ as the vibrational movement, please calculated the intensity of the Rayleigh scattering.

(hints: The scattering is caused by induced dipoles of molecules $\mathbf{p} = \alpha \cdot \mathbf{E}$)

Use your result to explain why the sky is blue, and why the sunset is red.