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Please, solve this problem and also show the steps to solve it.

20.06.2015 – N19

1)

a) What is the surface temperature of Betelgeuse, a red giant star in the constellation of Orion, which radiates with a peak wavelength of about 970 nm?

b) Rigel, a bluish-white star in Orion, radiates with a peak wavelength of 145 nm. Find the temperature of Rigel's surface?

Hint: Use Wien's displacement law

2) Let f be a positive differentiable function defined on $(0,\infty)$. Then

$$\lim_{n\to\infty}\left(\frac{f\left(x+\frac{1}{n}\right)}{f(x)}\right)^n \qquad (1)$$

a) equals 1; b) equals $\frac{f'(x)}{f(x)}$; c) equals $e^{\frac{f'(x)}{f(x)}}$ d) may not exist for some $f(x)$.

3) A monatomic gas obeys the van der Waals equation $P=\frac{N\cdot R\cdot T}{V-N\cdot b}-\frac{N^2\cdot a}{V^2}$, where N is the total number of particles, parameter a measure of the attraction between the particles and the parameter b is the volume of the molecules per mole. This gas has a heat capacity $C_V=\frac{3N\cdot k_B}{2}$ in the limit $V\to\infty$ (k_B - is the Boltzmann constant).

a) Prove, using he equation of state, that $\left.\frac{\partial C_V}{\partial V}\right|_T=0$.

b) Use the preceding result to determine the entropy of the van der Waals gas, $S(T,V)$ to within an additive constant.

c) Calculate the internal energy $\varepsilon(T,V)$ to within an additive constant.

d) What is the final temperature when the gas is adiabatically compressed from (T_1,V_1) to final volume V_2 .

e) How much work is done in this compression?

4) Suppose a spacecraft of mass m_0 and cross-sectional area A is coasting with velocity v_0 when it encounters a stationary dust cloud of density ρ. Solve for the subsequent motion of the spacecraft assuming that the dust sticks its surface and that A is constant over time.