1. In the sky of the distant Dog-zar planet in a galaxy far far away, a simple pendulum of length $\ell$, mass $m$, and color fuchsia is hung. The gravitational constant is $g$, and the temperature is a balmy $T_{\text{balmy}}$. What are the fluctuations in the angle of the pendulum? Now the pendulum is completely lowered into a viscous soup of temperature $T_{\text{tasty}}$, what are the fluctuations now? Explain your answer.

2. The Rexons of Dargon IV are renowned for their skill in the understanding of the deviation of the temperature $T$ from its equilibrium value $\Delta T = T - \langle T \rangle$, where the angular brackets denote an average. However, the distant Regularons of Fargoflop II are equally renowned for their skills with the understanding of the deviation of the volume $V$ from its equilibrium value $\Delta V = V - \langle V \rangle$. An intergalactic crisis may take place as each community claims that their method is equally and independently good! As a highly trained student of PHYS 559, you are called upon to resolve this potential problem! You must calculate the following quantities, making all aliens, including your professor, happy! Determine the following quantities, explaining your reasoning: $\langle \Delta T(\Delta V + \text{constant}) \rangle$, $\langle (\Delta T)^2 \Delta V \rangle$, and $\langle (\Delta T)^4(\Delta V)^2 \rangle$.

3. An interface of height $h(\vec{x})$ fluctuates due to temperature, where positions in space are denoted by $\vec{r} = (\vec{x}, y)$. That is, $y$ is the direction up, and $x$ denotes positions in the plane of the interface. These fluctuations cause the surface to wobble up and down a lot, so that the surface width $w$ is nonzero. Show that, under reasonable and minimal assumptions that the width is related to the height correlation function by $w = \sqrt{\langle h(0)^2 \rangle}$.

Now imagine we are instantaneously transferred to the heart of silicon valley in California where the new governor is stepping up high tech research by jump-starting molecular-beam epitaxy (MBE) growth research by offering highly-paid jobs to the graduates of this course! But they need some theoretical guidance... In MBE growth, material is added to the surface by shooting a molecular beam at it. If material is added at a constant rate $R$, then, of course, the average height of the surface grows with time $t$ as $Rt$. Find a simple expression for the width $w(t)$ of the growing interface, analogous to the one you just obtained, in terms of the time dependent interface correlations $\langle h(\vec{x}, t)h(\vec{x}', t) \rangle$ and $R$. 