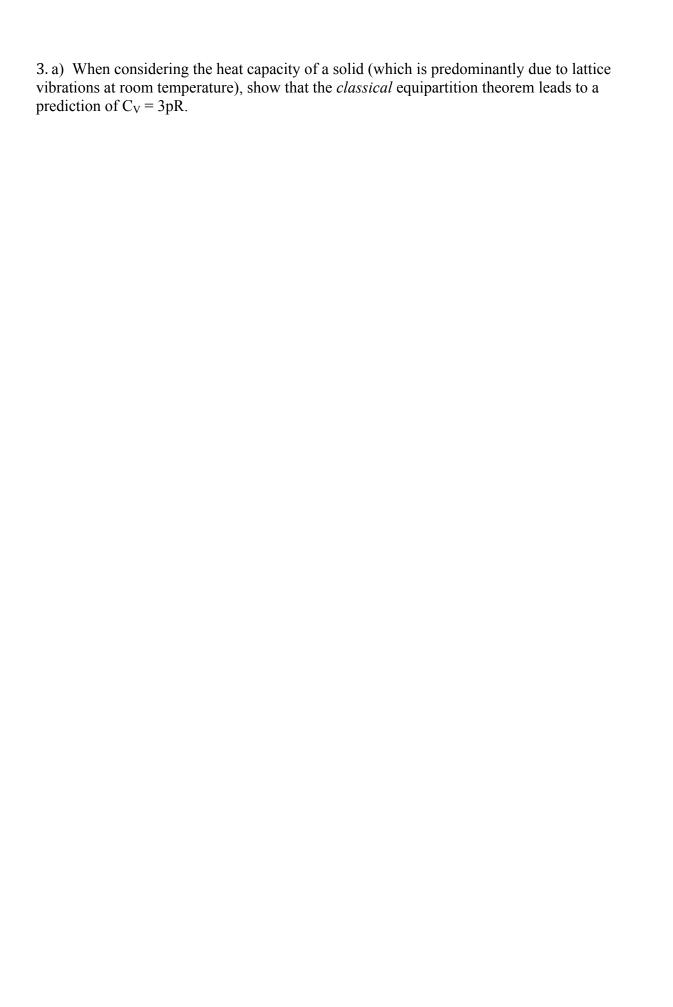
	Name:
1. DERIVE the density of states function for <u>electrons</u> in a	2-dimensional thin film (in
the "free electron" model, where the dispersion relation is	simply a parabola).

2. a) Discuss the <u>origins of resistance</u> in metals, including some description of experimental behaviors that tend to support your claims. For example, why do the resistivities of metallic elemental solids vary (roughly) linearly with temperature?
b) Estimate the <u>frequency</u> of electron scattering events in copper at 0 $^{\circ}$ C and 1 atm [You will need a <i>ballpark</i> estimate for the resistivity of a good metal.]
c) How would you calculate the <u>mean free path</u> of electrons in a metal?
d) What is the temperature dependence of the <u>mean free path</u> of electrons in a metal? [Look back at the functional form you provided in part (c), if you can. – As always, <u>explain</u> your answer <u>thoroughly</u> if you want credit (<i>i.e.</i> , provide a physical argument).]



b) Explain why $\theta_D > \theta_E$. [<i>Hint</i> : what is the physical origin of θ_D ? – Contrast the physical meaning of the Einstein Temperature with that of the Debye Temperature.]
c) Why do the heat capacities of solid elements become smaller as they are cooled below room temperature, and tend to zero at <i>low</i> temperatures?
d) Conversely, why don't quantum corrections <i>matter</i> at high T?

4. a) If the only change we were to make to a solid were to increase the elastic modulus, how would this affect the heat capacity at room temperature? Explain your answer.
b) Which has a higher molar heat capacity at room temperature, salt or diamond? Why?
c) SrTiO ₃ has, at times, been sold by jewelers as a "fake diamond" so Cheryl the Physicist has decided to measure the molar heat capacity of her engagement ring. Given
that C_P for diamond is, at room temperature, 6.113 J K ⁻¹ mol ⁻¹ should Cheryl the Physicist expect to find a higher, lower, or equal value for SrTiO ₃ ? Give (and explain) at least two reasons!!

5. Does the *low*-temperature-limit *thermal conductivity* data shown below (taken by Bill Huber and Gabe Spalding) tell you whether the sample is a conductor or an insulator? If so, which is it, and *how* do you know? [*Hint*: a straight line on a log-log plot indicates a "power law" relationship.]

