

Abstract Submitted  
for the MAR10 Meeting of  
The American Physical Society

**Investigating Student Understanding of Physics Concepts and the Underlying Calculus Concepts in Thermodynamics**<sup>1</sup> JOHN THOMPSON, University of Maine, WARREN CHRISTENSEN, North Dakota State University, DONALD MOUNTCASTLE, University of Maine — In work on student understanding of concepts in advanced thermal physics, we are exploring student understanding of the mathematics required for productive reasoning about the physics. By analysis of student use of mathematics in responses to conceptual physics questions, as well as analogous math questions stripped of physical meaning, we find evidence that students often enter upper-level physics courses lacking the assumed prerequisite mathematics knowledge and/or the ability to apply it productively in a physics context. Our focus is in two main areas: interpretation of P-V diagrams, requiring an understanding of integration, and material properties and the Maxwell relations, involving partial differentiation. We have also assessed these mathematical concepts among students in multivariable calculus. Calculus results support the findings among physics students: some observed difficulties are not just with transfer of math knowledge to physics contexts, but seem to have origins in the understanding of the math concepts themselves.

<sup>1</sup>Supported in part by the National Science Foundation, Maine Economic Improvement Fund and Maine Academic Prominence Initiative

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Date submitted: 20 Nov 2009

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