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Identifying student difficulties with aspects of partial differentiation in upper-level thermodynamics[1] JOHN THOMPSON, BRANDON BUCY, DONALD MOUNTCASTLE, University of Maine — We are investigating student understanding and application of mathematics in an upper-level undergraduate thermodynamics course. We asked students about the relationship between complementary partial derivatives of the isothermal compressibility (κ) and the thermal expansivity (β) of a substance. Both of these material properties can be expressed with first-order partial derivatives of the system volume. Several student responses implied a difficulty with the notion of variables held fixed during evaluation of a partial derivative. Specifically, when asked to find the partial derivative of one of these quantities with respect to a variable that was initially held fixed (e.g., $(\partial\kappa/\partial T)_P$), a common response was that this (mixed second-order) partial derivative must be zero. This difficulty persisted among students even after instruction. Although we have previously reported several difficulties with partial differentiation in the context of the Maxwell relations, the above tendency is not apparent in that context. We interpret these results as one example of student failure to appropriately link physical understanding with mathematical reasoning.

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