Many crystalline solids have constant pressure molar heat capacities at low temperature that obey

the Debye T3-Law, which is



where R is the ideal gas constant and TD is a constant characteristic of the material known as the Debye temperature. This equation for the heat capacity comes from theoretical consideration of the vibrational degrees of freedom of the crystal lattice.

1. The Debye temperature for lead is TD= 105 K. Using this value, calculate the standard molar entropy of lead at T=25 K.
2. The Debye model works well for electrically-insulating materials (eg. metal oxides); however, for metals the model is improved by addition of an electronic term that takes into account the contribution to the heat capacity from valence electrons (valence electrons in a metal are substantially delocalized and can be easily excited to higher energy states).

This electronic contribution to the molar constant-pressure heat capacity has the form



For lead the value of b is 3.10 x 10-3 J.K-2.mol-1. What is the value of the electronic

contribution to the heat capacity of lead at T=25 K? What fraction of the total heat capacity does

the electronic contribution represent?