phy2403 ps1 problem 2(d). Phonon energy density.
Ratio of the phonon energy density to the rest-mass energy density (in hardwood).

```
cHardWood = Quantity[3960, "m/s"] ;
(* https://www.engineeringtoolbox.com/sound-speed-solids-d_713.html *)
a0 = WolframAlpha["bohr radius in SI units", {{"Result", 3}, "QuantityData"}];
hbar = WolframAlpha[
   "reduced Planck constant SI units", {{"Result", 1}, "QuantityData"}];
densityOfOak = WolframAlpha["convert oak wood density to SI units",
   {{"AdditionalConversion", 1}, "QuantityData"}];
cLight = WolframAlpha["convert speed of light to m/s",
   {{"Result", 1}, "QuantityData"}];

rho[k_, c_] := (1 / (16 Pi^2)) hbar c k^4;
energyDensityPhonon = rho[1 / a0, cHardWood];
oakRestMassEnergyDensity =
  UnitConvert[densityOfOak * cLight^2, "Joules/meter^3"];

{{"c", "=", cLight}, {"c_hardwood", "=", cHardWood},
  {"a_0", "=", a0}, {"ħ", "=", hbar},
  {"ρ-mass_oak", "=", densityOfOak},
  {"ρ-energy_phonon", "=", energyDensityPhonon},
  {"ρ-mass_oak c^2", "=", oakRestMassEnergyDensity},
  {"ρ-energy_phonon / (ρ-mass_oak c^2)", "=",
   energyDensityPhonon / oakRestMassEnergyDensity}} // Grid
```

c	=	2.998×10^8 m/s
$c_{hardwood}$	=	3960 m/s
a_0	=	5.292×10^{-11} m
$\hbar$	=	1.055×10^{-34} s J
ρ-mass$_{oak}$	=	650 kg/m^3
ρ-energy$_{phonon}$	=	3.37325×10^8 J/m^3
ρ-mass$_{oak}$ c^2	=	5.8422×10^{19} J/m^3
ρ-energy$_{phonon}$ / (ρ-mass$_{oak}$ c^2)	=	5.77394×10^{-12}