

PHYSICS 250

Homework 2

Due in class, Monday October 13

All problems are from Kelly Ch. 2.

1. Qu. 1.
2. Qu. 5, (a) and (b).
3. Qu. 6.
4. Qu. 7(a).
5. Qu. 8(b).
6. Qu. 9(a).
7. Qu. 10.
8. Qu. 13.

9. **Additional question.**

In the famous Bardeen-Cooper-Schrieffer (BCS) theory of superconductivity (which is celebrating its 50th anniversary this week), the value of the energy gap at zero temperature, Δ_0 , is related the superconducting transition temperature, T_c , by

$$\frac{2\Delta_0}{T_c} = 8e^I,$$

where

$$I = \int_0^\infty \log x \operatorname{sech}^2 x \, dx.$$

- (a) Use Mathematica to evaluate I .

Lookup the significance of, and the numerical value of, the Euler-Gamma constant, usually written γ .

- (b) Determine the numerical value of $2\Delta_0/T_c$.

Again you can use Mathematica.

Note: Many superconductors were found to have a value for this ratio of around 3.5. The agreement of the BCS theory with this data was one of its first major successes. There are some materials with a larger values of this ratio. These materials are called “strong-coupling” superconductors, and require a more sophisticated theory than BCS.

- (c) (Optional). Determine I by a contour integral.

Hint: Consider a rectangular contour with corners at $-R, R, R + n\pi i, -R + n\pi i$, where n is an integer, and let $R \rightarrow \infty, n \rightarrow \infty$.