MY SOLUTIONS FOR "MODERN QUANTUM MECHANICS (3RD EDITION)" BY J. J. SAKURAI

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0. Introduction

This document is an archive of my solutions to Sakurai's "Modern Quantum Mechanics" textbook.

1. Chapter 1

1. We first recall that the average speed of a particle in a system with temperature T is given by

$$\bar{v} = \sqrt{\frac{8k_BT}{\pi m_{Ag}}}.$$

Suppose a silver atom moving at this speed passes through a region of length l_1 where it is accelerated upwards by a, followed by a region of length l_2 where it moves at constant velocity. The total upwards displacement is given by

$$\begin{aligned}\Delta z &= \frac{1}{2}a_z\left(\frac{l_1}{\bar{v}}\right)^2 + a_z\left(\frac{l_1}{\bar{v}}\right)\cdot\frac{l_2}{\bar{v}} \\ &= \frac{a_z l_1(l_1+l_2)}{2\bar{v}^2}.\end{aligned}$$

The separation between the spin-up and spin-down beams is twice this value.

The silver atom's magnetic moment has value $\mu = 9.27\times10^{-24}J/T$ and the vertical magnetic field changes by $\frac{\partial B_z}{\partial z} = 10T/m$; hence, the upward force is given by $F_z = \mu\frac{\partial B_z}{\partial z} = 9.27\times10^{-23}N$.

$$\begin{aligned}2\Delta z &= \frac{a_z l_1(l_1+2l_2)}{\bar{v}^2} \\ &= l_1(l_1+2l_2)\cdot\frac{F_z}{m_{Ag}}\cdot\frac{\pi m_{Ag}}{8k_BT} \\ &= (1m)(3m)\cdot(9.27\times10^{-23}N)\cdot\frac{\pi}{8(1.37\times10^{-23}J/K)(1273K)} \\ &\approx 6.22mm.\end{aligned}$$

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2.

$$\begin{aligned}
[AB, CD] &= ABCD - CDAB \\
&= -ACDB + A(CB + BC)D - CDAB \\
&= -AC(DB + BD) + A\{C, B\}D - CDAB + ACDB \\
&= -AC\{D, B\} + A\{C, B\}D - C(DA + AD)B + CADB + ACDB \\
&= -AC\{D, B\} + A\{C, B\}D - C\{D, A\}B + (CA + AC)DB \\
&= -AC\{D, B\} + A\{C, B\}D - C\{D, A\}B + \{C, A\}DB
\end{aligned}$$