

## Spring 2009 Physics 2170 Homework Assignment 14 — LAST ONE!

Show all work. This assignment is due Thursday, April 30, 2009 at 12:50pm in the wood cabinet at the entrance to the physics help room (Duane G2B90). The assignment is worth 50 points.

1. (8 points): TZ&D 8.43. Does this match up with what you found on the previous homework set for the average value of  $x$  (problem 8.42)? You may find the following integrals useful

$$\int x^m e^{ax} dx = \frac{x^m e^{ax}}{a} - \frac{m}{a} \int x^{m-1} e^{ax} dx$$
$$\int x e^{ax} dx = \frac{ax - 1}{a^2} e^{ax}$$
$$\int e^{ax} dx = \frac{e^{ax}}{a}$$

2. (5 points): TZ&D 8.48

3. (5 points): A bunch of atoms are sent through a Stern-Gerlach experiment and the atoms separate into 4 lines, two above the centerline and two below the centerline. Note that the Stern-Gerlach experiment operates on the z-component of the *total* angular momentum. The z-component of the total angular momentum is given by  $J_z = L_z + S_z$ . Explain how this result comes about. In particular, give the atomic quantum numbers for the four different results. That is, what are  $n$ ,  $\ell$ ,  $m$ , and  $m_s$  for these four lines? There can be multiple possibilities for some quantum numbers.

4. (5 points) TZ&D 9.8

5. (6 points) TZ&D 10.6

6. (5 points): TZ&D 10.18

7. (5 points): TZ&D 10.20

8. (5 points): TZ&D 10.32

9. (6 points): Consider a particle in the  $n = 4$  energy eigenstate of the infinite square well which extends from  $x = 0$  to  $x = a$

- What is the expectation value of the position  $\langle x \rangle$ ?
- What is the *approximate* probability of finding it within a very small (say  $0.001a$ ) region around this point?
- Explain how these two results make sense (or don't).