# Problem Assignments for Unit 3

Unless otherwise indicated, problems are from Wolfson. "**Supp**" refers to chapters in the supplementary reading and "A" refers to the additional problems that are available at the beginning of the Supplementary Reading booklet.

## Assigned Problems for Wednesday, March 25

**Supp CH 3:** 4, 5, 6, 7, 9, 10, 11, 13, 14, 16

## Assigned Problems for Friday, March 27

**Supp CH 4:** 1, 2, 4, 6, 9, 10, 12, 13, 14, 16

## Hand-In Set #7 Due Monday, March 30, 4:30 pm

**Supp CH 3:** 2, 3, 8, 15, 17; **Supp CH 4:** 3, 11, 15, 17, 18

## Assigned Problems for Wednesday, April 1

A74; **Supp CH 5:** 1, 3, 5, 9, 10, 11, 14, 17, 20

## Assigned Problems for Friday, April 3

**Supp CH 6:** 1, 2, 3, 4, 5, 6, 7, 8, 10, 16

## Hand-In Set #8 Due Monday, April 6, 4:30 pm

**Supp CH 5:** 4, 12, 13, 15, 19; **Supp CH 6:** 11, 12, 13, 14, 15

## Assigned Problems for Wednesday, April 8

X13; **Supp CH 7:** 2, 3, 4, 9, 11, 12, 13, 15

**Notes:** Problem X13 can be found on the calendar page for Lecture 19.

## Assigned Problems for Friday, April 10

**Supp CH 8:** 1, 2, 3, 4, 5, 8, 9, 10

**Updated Problem 9:** Suppose we modified Bell's experiment and aligned the positron detector to be at a 60° angle with respect to the $z$-axis.

(a) In quantum mechanics, if the electron is measured to be spin down ($S_z^{\text{elec}} = -\hbar/2$), what is the probability that the positron will be found to have $S_{60^\circ}^{\text{pos}} = +\hbar/2$?

(b) Now we turn to hidden variable theories. Bell's theorem states that for all possible hidden variable theories, if the electron is measured to be spin down ($S_z^{\text{elec}} = -\hbar/2$), then the probability that the positron will be measured spin up must obey the inequality $\text{Prob}(S_\theta^{\text{pos}} = +\hbar/2) \leq 1 - \frac{\theta}{180^\circ}$. For this 60° rotated detector, calculate the upper bound on this positron probability.

(c) In this case, are the predictions of quantum mechanics and hidden variable theories compatible? Why or why not?

## Hand-In Set #9 Due Monday, April 13, 4:30 pm

**Supp CH 7:** 5, 10, 14, 16; **Supp CH 8:** 11, 12, 13, 14, 15

**Updated Problem 15:** Suppose we modified Bell's experiment and aligned the positron detector to be in the $+x$ direction. That is, we will measure the $S_x$ value for the positron.

(a) In quantum mechanics, if the electron is measured to be spin down ($S_z^{\text{elec}} = -\hbar/2$), what are the probabilities that the positron will be found to have $S_x = \pm\hbar/2$?

(b) Now we turn to hidden variable theories. Bell's theorem states that for all possible hidden variable theories, if the electron is measured to be spin down ($S_z^{\text{elec}} = -\hbar/2$), then the probability that the positron will be measured spin up must obey the inequality $\text{Prob}(S_\theta^{\text{pos}} = +\hbar/2) \leq 1 - \frac{\theta}{180^\circ}$. For this positron detector oriented in the $+x$ direction, calculate the upper bound on this positron probability $\text{Prob}(S_x^{\text{pos}} = +\hbar/2)$.

(c) In this case, are the predictions of quantum mechanics and hidden variable theories compatible? Why or why not?