Homework 16
Due Tuesday, April 16$^{\text{th}}$ in class

Reading from Chapters 15 & 16 of J & F-R

Chapter 15 of lays out some basics of classical physics and calculus, and their connection to discussions about time. We ask that you read the first few pages of the chapter, but only go further if you think reading more deeply will help you understand the ideas of Chapter 16 better. If you don't know this physics and math a bit already, it is unlikely that you would get too much out of reading this chapter in detail.

Chapter 16 provides a condensed look at how relativity and quantum physics have an impact on the processes of time, giving you another perspective on ideas that we have already studied. The writing questions below relate to reviewing those ideas. The chapter then introduces the physics of symmetry. These are ideas we will come to later in the semester, so think of this as a first reading.

A nice checklist of the ideas we have already covered about what physics tells about time is found on p. 198 of J & F-R:

- Time is relative, not absolute. (Einsteinian, not Newtonian)

- Time has a direction. (Although the fundamental laws of physics do not)

- Measurement of time is limited by the laws of nature.

- Time scales based on different laws of physics will not necessarily agree.

- A better understanding of nature improves time measurement, and *vice versa*.

Writing Questions to Hand In:

1. Give some examples of laws of nature that we have encountered which set limits on the precision or accuracy of time measurement processes.

2. Pages 204-5 give a discussion about the complementary aspects of measuring lifetimes and frequencies, in which more certainty in one must lead to less certainty in the other. Relating what you read there to work we have already done, put into words your own understanding of the relation between the two different ways that we have described the Quality Factor:
   . • The ratio $Q = f_0 \, / \, \Delta f$
   . • Number of cycles until an oscillation reduces to a small fraction of its initial energy.

3. Give us at least two questions related to the discussion of symmetry in the last section of Chapter 16, to help us prepare our treatment of these ideas.