

Astronomy 142: Review Guide For Final Exam

The final is Monday, March 16, 11:30 am - 1:18 pm, in the usual classroom.

Review Sessions

David Nataf (TA) and I will hold several review sessions, in the hope that we can accommodate those with different schedules. All review sessions will be in McPherson 4054.

Wednesday, March 11, 5:30 pm - 6:30 pm: David Nataf will review the solutions to Homework 3 and 4 and the equations on the back of this review sheet.

Thursday, March 12, 5:15 pm - 6:30 pm: I will hold a Q&A review session. It's up to you to come in with questions, but you will probably learn from the answers to your classmates' questions as well as your own.

Friday, March 13, 4:30 pm - 6:00 pm: This is a "backup" Q&A review for those who can't make Thursday. I will do 4:30-5:15, and David Nataf will do 5:15-6:00.

Attending one of the Q&A review sessions will almost certainly improve your performance on the final. The more reviewing you have done in advance, the more helpful it will be. The Wednesday review session will be helpful if you are still fuzzy on the homework solutions despite reading my solution sets; concepts from the homework will reappear on the final. You are welcome to attend as many reviews as you like.

Mechanics

The exam will be mostly multiple choice, similar in style to the midterm, but longer in total number of questions, and perhaps with a few questions designed to take more time and thought to answer. I have not decided yet whether there will be an essay question.

You may bring your page of handwritten notes from the midterm *plus* one *new* page (both sides) of handwritten notes, and a calculator.

Topics and review advice

The exam will cover the empirical evidence for General Relativity (starting with the "General Relativity and Newtonian Gravity" section in Part 6 of the course notes) and all material in the latter part of the course (Part 7, General Relativity and Black Holes, through Part 12, Gravity Waves). This material does draw on our treatment of Newtonian gravity and relativity from the first half of the course, so in that sense the exam is necessarily "cumulative."

The most useful way to review is (probably) to go carefully over the lecture notes and the solution sets to Homework 3 and 4, making up your handwritten notes as you go. The Broderick & Loeb article on imaging black hole silhouettes, which I handed out in class, provides a good review of the ways we learn about black holes from observations; it will be helpful to re-read this article near the end of your reviewing.

Pay particular attention as you review to how physicists and astronomers have built up the evidence for the existence of black holes over the last 100 years (almost), and the combination of theoretical arguments and astronomical observations that lead us to think that black holes exist and have the properties predicted by General Relativity. Pay attention to the roles that radio astronomy, X-ray astronomy, and "traditional" (visible light) astronomy have played in this story, and the role that gravity wave astronomy might play in the future.

Names you should know: Newton, Einstein, Schwarzschild, Chandrasekhar, Oppenheimer, Wheeler, Hawking

Equations

In addition to the equations reviewed for the midterms, you should be familiar with the following equations — what quantities are represented by the variables, what principles the equations express, and how they can be used:

$$\begin{aligned}\theta &= \frac{R_{\text{Sch}}}{r} \quad (\text{Homework 3, Part III}) \\ E &\sim \frac{GM^2}{R} \\ L &\approx \frac{1}{12} \dot{M} c^2 \\ L_{\text{Edd}} &= 3 \times 10^4 L_{\odot} \left(\frac{M}{M_{\odot}} \right) \\ M &\approx \frac{v^2 r}{G} \\ h &\approx \frac{1}{5} \frac{R_{\text{Sch}}}{D} \\ P &\sim \frac{2\pi R_{\text{Sch}}}{c} \approx 10^{-3} \left(\frac{M}{10M_{\odot}} \right) \text{sec}.\end{aligned}$$

You should remember that the Schwarzschild radius for $1M_{\odot}$ is 3 km.