Introduction and Organization

Welcome to the *Instructor's Resource Manual* (IRM) for the 5th edition of Chaisson and McMillan's *Astronomy Today*. Earlier editions of the *Instructor's Resource Manual* to accompany the Chaisson/McMillan textbook were prepared solely by Dr. Leo Connolly of the Department of Physics, California State University, San Bernardino, California. The current edition incorporates much of his earlier work. Specifically, all of the student writing questions and many of the responses to review and discussion questions were prepared by him. In addition, many of his excellent ideas, teaching suggestions, and problem solutions have been retained in the text of the current manual. Also heavily drawn upon is the *Instructors Resource Manual* to accompany Chaisson/McMillan's 4th edition of *Astronomy: Beginners Guide to the Universe*. Written by Judith Beck of the University of North Carolina, the manual provided the inspiration for the format of the chapters in this IRM and many of her excellent and insightful recommendations and ideas have been incorporated here in the introduction as well as throughout the manual.

This *Instructors Resource Manual* is designed to help you, the instructor, organize your thoughts and materials for classroom lectures and activities. You will find that the chapter layout is designed to match that of the textbook. In each section you will find a chapter outline, summary, list of major concepts, lecture and demonstration suggestions and answers to the end-of-chapter questions as well as solutions to the end-of-chapter problems. At the end of each chapter you will find a list of the accompanying transparencies and suggestions for materials that might aid in your class discussions. Each chapter concludes with suggested readings pertaining to the text book chapter content followed by writing space for your own personal notes and observations.

Teaching Introductory Astronomy

If you are teaching this course under typical circumstances, you will likely find that the majority of your students are non-science majors. However, your students are there to learn about science. Astronomy is an excellent subject with which to introduce your students to science because of its scope and history and the subject can be approached on many levels from purely descriptive to intensely theoretical. The use of mathematics, then, is not required in order to develop the concepts, but may be used if appropriate to the backgrounds of your students. Even students who bring no mathematics background to the course will be able to follow and benefit from a few basic equations such as those contained in Newton's 2nd law or the universal law of gravitation. If your course is on the "descriptive" or "conceptual" end of the spectrum, the students may tend to have anxieties about mathematics. Don't let that stop you from introducing a few equations here and there. Equations can be discussed without expecting the students to use or to solve them. If you plan on teaching nearer to the theoretical end of the spectrum, you will find plenty of background and support material in the text as well as many problems ranging from easy to difficult.

Many students enter an introductory astronomy class already fascinated by the subject, even if they do not yet know much about it. Capitalize on their interest and enthusiasm! In teaching astronomy, you have the opportunity to present some of the most bizarre, immense, baffling, and complex structures and ideas in science. Challenge your students to engage with and question them. Present the study of astronomy as a human endeavor, as a quest for understanding, and as an enriching, exciting experience. Your students will reward you by rising to the occasion!

Course Organization and Structure

Lectures, discussions and presentations

The days of the "sage on the stage" are, for the most part, falling away into oblivion. Research in recent years has shown that relatively few students learn well from sitting and listening to an instructor reciting facts[1]. Interactive learning and peer instruction are increasingly being brought into the classroom with great effect. Mixing this **cooperative learning** into your lectures will have not only positive results in the information retention of our students, but it will improve on their problems solving skills while making the course more enjoyable as well. Although you will find that interactive activities are more easily implemented in smaller class settings, you can encourage cooperative learning among students even in large classes. Pose a question and have students discuss it with their closest neighbor (or two) for a very short time, such as one minute. Then call on several random groups to give their responses. For some topics you can ask students to make predictions or guesses and then write a few of them on the board. This technique not only gets students more involved in the class, it also helps them apply knowledge they have gained to new situations and avoid seeing astronomy as a string of unrelated numbers.

The **daily structure** of your course will depend upon several factors, including class size, resources available to you, and your own teaching style. For a small class, you may engage in frequent discussions, question/answer sessions, and/or student presentations on specific topics. If you have a large lecture class, you will probably not have the luxury of extended class discussions and there will likely be insufficient time for presentations by each and every student. However, there are a number of ways you can still encourage an interactive atmosphere with your students. Students tend to find demonstrations and models particularly engaging when their peers are involved, so ask individuals to come forward to help you with presentations. Even in large classes you can encourage questions from your students; sometimes they are insightful, which adds tremendously to your presentation, and other times students' questions can point out misconceptions you may not otherwise recognize and address.

Astronomy is a very visual science. Take advantage of the large collection of **slides** or **transparencies** made available by the textbook publisher. You may wish to augment your collection by purchasing other educational slide sets. There are many different ways you can employ the images. For instance, you may wish to break the lecture in the middle each day, dim the lights and have a slide show concerning the topic of the day. Or, you can save all the images for the end of class to use as a conclusion and review. Finally, you may choose to have the slides interspersed throughout the lecture. Include images of people if possible, both historical figures (Galileo Galilei, Annie Jump Cannon, Edwin Hubble,) and contemporary astronomers (Margaret Geller, Murray Gell-Mann) to illustrate the human side of astronomy.

If you are teaching in a "smart classroom," you can access the **Companion Website** and show animations illustrating particular concepts. Other Websites can also be employed. For instance, when discussing the Sun, you can bring up current photos of the Sun to show the locations of sunspots. Even after moving on to other topics, you can take a minute at the beginning of class each day for a week to view the Sun so students can watch the motion of the sunspots and even estimate the rotational period of the Sun. Be sure to plan your Website "fieldtrips" ahead of time and check the locations before class, so you don't spend class time surfing or hunting down broken links.

Demonstrations, models, and visualizations add an important dimension to any science class. Models are particularly helpful in astronomy, which deals with dimensions and distances that are

[1] McKeachie, W. *McKeachie's Teaching Tips*, Houghton Mifflin, 2002

hard for students (or anyone else!) to comprehend. Demonstrations enliven presentations and help students understand (and remember) concepts.

Finally, whatever balance of lecture, demonstration, interaction, and visual presentation you decide is right for you, make sure your own enthusiasm for the subject shines through. Your fascination with and passion for astronomy will leave a lasting impression on your students, and will aid in their learning at least as much as demonstrations and slide shows will.

Student Evaluation

No single evaluation method is accurate for every student. For this reason, you should consider using a variety of methods of evaluation. Possibilities include homework, quizzes, tests, laboratory or classroom exercises, group activities, written assignments, and projects. You may also choose to require attendance and therefore have it contribute to a student's final grade. Whatever your policies regarding grading, make sure that they are clearly stated in the syllabus and applied fairly and consistently. Remember also that evaluations not only help you assign grades to students, they also help you keep your finger on the pulse of a class. For both the students' sake and your own, don't wait until midterm to give students feedback in the form of a grade. If the class averages for the first few quizzes are extremely low, then you know you are not getting across to students and can determine what needs to be changed.

There are many ways to encourage and motivate students to keep up with class. Homework and quizzes are two of the most common methods. Each chapter in the textbook includes 20 conceptual self-test questions, 20 review and discussion questions and 15 numerical problems. Subsets of these can be assigned for **homework**. The problems range from fairly simple to quite complicated; use those that are appropriate for the level of your students. Homework may be collected weekly or the assignments may be retained by each student and kept as part of an **assignment notebook** or **portfolio**. The assignment notebook may be handed in on test day and quickly reviewed and assigned a grade or simply a check mark for completion. You could even give points for such things as neatness and cover art. The students usually appreciate having some type of "souvenir" of their work and the assignment notebook is an excellent way to provide that.

Quizzes provide another way to encourage students to stay engaged and caught up. A relatively simple and short quiz given at the beginning of class on the due date of a homework assignment serves two purposes. It is an incentive for the students to complete the assignment on time and it is a way for you to regularly take the class's "pulse". Quizzes also provide the opportunity to ask the students questions about the previous class meeting (which encourages them to look over their notes) or questions about the material to be covered that day (which encourages them to read the material before coming to class). Alternatively, use technology and give a quiz via computer that must be completed before class. The in-class quiz can also be used as an attendance check and as an incentive to get to class on time; the Web quiz allows you more class time for new material. A short quiz given at the end of a class period is yet another option; it can be used to assess student understanding of the day's material and as an attendance check.

Class size will probably have some influence on the format of your **tests**. Very large classes usually dictate the necessity of multiple-choice and other objective-question tests. For smaller classes, you may opt to include some discussion or essay questions. Since visual images are an important part of an astronomy class, consider including some identification or other questions based on images. You can attach diagrams or photos to the test itself, but you will find that the students enjoy seeing slides or transparencies displayed at the front of the room during the test. It seems to help reduce anxiety. For a semester (15 week) course, two or three tests instead of a single midterm are usually the most effective. Prentice Hall Custom Test provides the opportunity for online testing, tailored to your specific needs.

Many campuses are emphasizing "**writing across the curriculum**," so we have included a set of student writing questions in each chapter of the IRM, which provide an opportunity for student writing in the sciences. You can select one or more of these questions as a writing assignment or you can let the students select them for you. Also, you are certainly welcome to make up your own to tie in with class discussions or personal interests. The questions are intended to stimulate creativity, imagination, and critical thinking. Avoid assigning questions that require students to repeat what they have just read or that may have canned answers found on the internet.

Another way to "mix it up" is to assign small-group or individual **projects.** These can be wonderful and challenging experiences for students in this type of astronomy course. Observing projects can range from one-night to semester-long assignments. Examples include tracking the motion of a planet with respect to the background stars, plotting the position of sunrise or sunset against fixed objects on the horizon, drawing the moon's phases, plotting the motions of the moons of Jupiter, observing and sketching astronomical objects, and following the motion of the Sun by measuring daily shadow lengths. Non-observing projects are also possible. For instance, throughout the course models are very useful for illustrating various concepts. Small groups of students can be assigned different modeling projects to design and construct. Possibilities include models of the solar system, the interior of the Earth, the layers of the jovian planets, the Milky Way, the Local Group, etc.

Exactly how you determine final grades will depend on your personal preference, whether or not the course has a laboratory component, and institutional culture. In particular, check to see if there are expectations regarding what percentage of the final grade is determined by the final exam. Most campus departments require some type of course master to be on file. Refer to this document (ask your department chairperson) to be sure that you are including all of the required material expected for whatever level course you are teaching. At the very minimum, be sure to include everything advertised for the course in the college bulletin or catalogue.

Whatever evaluation methods you choose, be sure to set up a point schedule where a known number of points are assigned for a given amount of work (e.g. 10 points per quiz). Avoid the possibility of assigning points in any kind of subjective way. If the points are awarded purely objectively, then you will not have many arguments concerning grades and if you do, you will be able to provide a solid argument for how points were derived and totaled. You can maintain a certain amount of flexibility by including it in your grading scheme. Such things as dropping the lowest quiz or homework assignment of even test helps to reduce anxiety as well as provides some flexibility concerning absences. If you allow the students to drop something, then you will feel much less guilty about not allowing make-ups, etc.

You might want to consider using an electronic spreadsheet such as Microsoft Excel® to keep track of points. You will have immediate access to semester totals for each student, which will enable you to provide very timely feedback for grade inquiries. Remember to state very clearly on your syllabus how grades will be computed. Three example grading schemes are given below and you will find another in the example syllabus below.

Scheme 1: One-semester course with lab

> Labs and Projects 15%; Homework and Quizzes 20%; Tests (2 @ 20%) 40%; Final Exam 25%
>
> Grading scale: A: 90–100, B: 80–89, C: 70–79, D: 60–69, F: 0–59

Scheme 2: One-quarter course with lab

> Labs and Projects 20%; Homework and Quizzes 25%; Midterm 25%; Final Exam 30%

Grading scale: A: 90–100, B: 80–89, C: 70–79, D: 60–69, F: 0–59

Scheme 3: Semester or quarter course without lab

Homework and Projects 20%; Quizzes 15%; Tests (1 or 2) 30%; Final Exam 35%
The lowest quiz grade and the lowest homework grade will be dropped.

Grading scale: A: 90–100, B: 80–89, C: 70–79, D: 60–69, F: 0–59

Syllabus

It is important to provide your students with a clear syllabus at the beginning of the course. The syllabus is a contract between you and your students and should therefore convey all relevant information concerning your plans and expectations for the course. Include your office hours and contact information, course objectives, goals and expectations, grading criteria, resource information, a schedule, and general policies, including issues from plagiarism and cheating to snow days and absences due to campus-related activities. An example of a syllabus and one you can use as a starting point is:

(Beginning of sample syllabus)

Descriptive Astronomy
ASTR131

Monday, Wednesday 9:40 – 11:00
Rm. S3

Instructor

Steven R. Murrell
Office: S-17
Office Hours: Posted
e-mail: smurrell1@hfcc.edu

Text

Astronomy Today, 5th Edition, Chaisson and McMillan

Course Structure

	Subject	Chapters	Tentative Exam Date
Part I	Overview, Celestial Sphere Moon Phases, Eclipses History, Physics, Telescopes	1-5	September 15th
Part II	The Solar System	6-15	October 20th
Part III	Stars	16-22	November 20th
Part IV	Galaxies, Cosmology Search for Extraterrestrial Life	23-28	December 15th *(FINAL)*

Student Evaluation

3 Mid-term Exams, (50 points each, dropping the lowest one)	100 points

Final Exam (cumulative / comprehensive)	100 points
Weekly Quizzes/Activities (10 points each, drop lowest one)	120 points
Assignment Notebook	130 points
Attendance/Participation	50 points
Total	500 points

Exam Preparation and Grading

The best way to adequately prepare for exams is to complete the homework assignments and participate in the class discussions. Of the four mid-term exams offered, you will be able to drop the lowest grade. The best three scores will count toward your semester total. The final exam will include material from part IV as well as cumulative/comprehensive material and cannot be dropped. Exams are not returned (but will be held in my files, pending student questions/concerns). Exam grades, as well as running semester totals, will be posted in the back of the room with student identity protected. Questions or concerns will be handled on an individual basis.

Weekly Quizzes/Activities

Quizzes and/or activities will test your comprehension of the material offered in the lectures and the reading/homework assignments. A typical quiz might contain a handful of multiple choice or true-false questions *or* one or two short essay questions. Occasionally, an in-class activity will be performed instead of a quiz. Quizzes/Activities cannot be made up, but the lowest single score will be dropped.

Assignment Notebook

Weekly homework assignments will be given. Rather than hand these assignments in every week, you will include them in a binder, which will be referred to as your "assignment notebook". This notebook will be handed in on the day of each exam and briefly examined for content/completion and then returned to you after the exam. A total of 130 points will be awarded as follows: 80 points for completion level; 30 points for neatness of print and diagrams; 10 points for interesting cover art; 10 points for including assignment hand-out sheets demarking each assignment section. At your discretion, you may bring your notebook to class at anytime for guidance or informal evaluation.

Attendance Policy

HFCC has a mandatory attendance policy. Additionally, the lectures are designed to supplement and complement the material in the book so missing class will likely have a direct negative effect on your ability to do well on exams, quizzes and homework assignments. Material covered in class will not be made available at any other time. As an extra incentive, each student will start the semester with 50 attendance points. Each recorded absence will result in a 10-point deduction. Late arrivals will be marked as half an absence (5 points).

Academic Honesty

All students without exception are expected to do their own work. Any kind of dishonesty whether it be in the form of cheating on a test, copying (plagiarizing) the work of fellow students or published work, etc. will result in a failing grade for the course. This policy will be strictly enforced.

Final Grades

Your grades will not be curved (in the traditional sense). However, adjustments will be made to insure that each of the five exams will have a class average of at least 75%. (e.g.

If the class average on a particular exam is below 75%, every student will be awarded the same number of additional points until the class average meets or exceeds 75%) The following total semester points will guarantee the corresponding final letter grades.

480 – 500	A+	380 – 399	C+
465 – 479	A	365 – 379	C
450 – 464	A-	350 – 364	C-
430 – 449	B+	330 – 349	D+
415 – 429	B	315 – 329	D
400 – 414	B-	300 – 314	D-
		<300	E

(End of sample syllabus)

You may also wish to include hints and suggestions for success. The following is a (partial) list of suggestions for your students; you will undoubtedly have some favorites of your own to include.

- Prepare for class; read material in the text *before* the lecture. Then read the material again after class discussions of the topics.
- Use your resources, including the text and the Companion Website.
- Don't miss class; get notes from someone if you have an unavoidable absence.
- Review and practice math as necessary.
- Participate in class.
- Keep up with homework and projects.
- Form a study group.
- Practice, practice, practice.
- Let me know how you're doing!

Sample schedules

The textbook is intended for use with a one-quarter, one-semester, or a two-quarter course. Obviously, the depth with which you probe the chapters will depend on the allotted time for the course. When planning your schedule, be sure to include time for whatever form of evaluation you intend to use. Tests are commonly given at regular intervals such as after each unit or section. As shown in the text the course can be easily divided into four main units or parts. These are conceptual blocks and can be conveniently tested by offering an exam for each one. The material covered by the final exam will depend on how many midterms were offered and can include material covered since the previous midterm or may be cumulative or a combination of both.

Sample schedules for a 1-semester and a 2-quarter course are presented in the following tables. They assume a 15-week semester or a 10-week quarter with a separate final exam period at the end of the course. One midterm exam per quarter and three midterm exams in the semester format have been included in the schedules.

Sample Schedule for a 1-Semester Course	
Week #	Chapter or Activity
1	1 & 2
2	3 & 4
3	5 & Midterm #1

4	6 & 7
5	8 & 9
6	10 & 11
7	12 & 13
8	14 & 15
9	Midterm #2 and Ch.16
10	17 & 18
11	19 & 20
12	21, 22 and Midterm #3
13	23 & 24
14	25 & 26
15	27 & 28 (final review)

Sample Schedule for a 2-quarter Course			
First quarter		Second quarter	
Week #	Chapter or Activity	Week #	Chapter or Activity
1	1 & 2	1	16 & 17
2	3 & 4	2	18 & 19
3	5	3	20 & 21
4	Review and midterm	4	22
5	6 & 7	5	Review and midterm
6	8 & 9	6	23
7	10 & 11	7	24 & 25
8	12 & 13	8	26
9	14 & 15	9	27 & 28
10	Review for final	10	Review for final

Teaching Resources

Supplementary materials

In addition to this *Instructor's Resource Manual*, there are a number of other resources available from the publisher. Over 275 of the figures and tables from the text are reproduced as *transparencies* or *slides* for instructor use. A *test item file* is also available. An e-book *CD*, including a hyperlinked electronic version of the text, is included free with every textbook. Be sure to visit the *Companion Website* (linked from the site http://astro.prenhall.com/chaisson) and encourage your students to take advantage of the excellent resources available there. See the text preface for more details on these and other resources.

Organizations and publications

The two publications *Sky and Telescope* (http://skyandtelescope.com/) and *Astronomy* (http://www.astronomy.com/home.asp) are excellent magazine resources for both instructors and students of astronomy. In addition to interesting and current articles, each issue contains a sky chart for the month and suggestions for observing.

The American Association of Physics Teachers (AAPT) publishes the *American Journal of Physics* and *The Physics Teacher*, which often contain articles related to teaching astronomy as well as to teaching physics. In addition, AAPT sponsors workshops and meetings on teaching innovations. (http://www.aapt.org)

The National Aeronautics and Space Administration (NASA) provides a wealth of resources for students and educators. Visit their website at http://www.nasa.gov for news, educational opportunities, products, photos, videos, announcements, and just about anything you can imagine related to the space agency.

Abrams Planetarium, Michigan State University, East Lansing MI, 48824, publishes a monthly *Sky Calendar* available at a subscription cost of $10 per year. The one-page calendar summarizes important observational events of the month and is an excellent resource for a quick overview of what to look for and when. See also the planetarium's *Skywatcher's Diary* available on the web at http://www.pa.msu.edu/abrams/diary.html.

The Astronomical Society of the Pacific (ASP) has many excellent educational materials related to astronomy, including slide sets, videos, and models. Visit http://www.astrosociety.org/ or call 800-335-2624. The Website contains astronomy news as well as products for sale.

The Harvard Smithsonian Center of Astrophysics has developed *Project Star Hands-On Science Materials* appropriate for introductory college astronomy classes and labs. Examples of their materials include refracting telescope kits, spectrometer kits and celestial sphere kits. The products are available at Learning Technologies, Inc., 40 Cameron Avenue, Somerville, MA, 02144. You can also call for a catalog (800-537-8703) or visit http://www.starlab.com.

Several companies supply scientific equipment and materials for demonstrations and labs. If you don't already have a favorite, try Edmund Scientific, which has a good selection of astronomy related products. (See http://www.scientificsonline.com.) Fisher Scientific (http://www.fishersci.com/) and Sargent-Welch (http://www.sargentwelch.com/) are also good choices. They list astronomy products under the heading of Earth sciences.

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