ASTR 101 — Homework #5 (Lectures 14–17)

Practice problems from The Sun, Measuring the Stars, the H-R Diagram, and Binary Stars

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❗ Weekly Homework + Grade Memos (15%)

Homework builds quantitative fluency and model-based reasoning. Expect multi-step problems and conceptual questions where units, assumptions, and physical interpretation matter as much as the final number. The purpose of homework is exam preparation and skill-building through consistent, high-quality practice — not busy work.

Submission workflow (two-stage)

Homework Solutions — due Monday 11:59 pm PT (Canvas)

- Must be uploaded as **one single, readable PDF** (not a photo dump).
- Organize clearly. Show your work. Label final answers.

- **No late submissions.** Instructor solutions will be posted Tuesday morning, so late work cannot be accepted.
- **Lowest homework score will be dropped** (to cover one off-week or emergency).

Self-Assessment + Reflection ("Grade Memo") — due Wednesday 11:59 pm PT (Canvas)

- Self-assess (self-grade) your work using the homework rubric (posted on Canvas) and the posted solutions/guidance.
- Submit a brief grade memo that includes:
  - what you got right (and why),
  - what broke (and where),
  - what you learned,
  - what you will do differently next time.
- Your grade memo must also include:
  - a per-problem self-rating (1–5) with brief justification, and
  - AI and collaboration disclosure (even if "none").
- Vague memos (e.g., "I need to study more") will not earn full credit unless they include a specific error diagnosis and a concrete next-step habit.

How your homework is graded (Instructor 0–5 score)

I evaluate your combined submission (Monday solutions + Wednesday grade memo) and assign an overall score from 0–5. Homework is graded primarily on completion, professionalism, and learning behaviors, not just final correctness. "Professionalism" here means your work is readable, logically organized, shows steps and units, and reflects honest effort. Your grade memo is graded on the quality of your self-assessment, reflection, and evidence of growth.

⚠ AI Policy

Allowed (study support):

- Clarifying your own notes or assigned readings
- Generating practice questions (not answers to assigned problems)
- Explaining concepts at a different level *for studying*

Not allowed (graded work):

- Generating or rewriting homework solutions, derivations, or explanations you submit

- Submitting AI-generated reasoning you cannot reproduce on your own

Always disclose AI use in your grade memos, even if the use was allowed.

Topics: *solar structure and fusion • distance, brightness, and luminosity • H-R diagram interpretation • binary stars, stellar mass, and stellar lifetimes*

Estimated time: ~4-6 hours

Posted: Wednesday, March 25, 2026

Note

For **Homework #5 only**, the homework problem set is assigned **Wednesday, March 25, 2026** and your worked solutions are due **Tuesday, April 7, 2026 at 11:59 pm PT** on Canvas. The self-assessment grade memo is due **Friday, April 10, 2026 at 11:59 pm PT** on Canvas. This longer window accounts for Spring Break.

Why this homework exists (read this)

This is not busy work. This assignment is the first big checkpoint in Module 2. We begin with the Sun as a nearby physics lab, then move outward to the tools astronomers use to infer hidden stellar properties from light and orbital evidence.

This assignment is designed to:

- reinforce the Observable -> Model -> Inference chain for stars,
- connect distance, brightness, luminosity, radius, and mass instead of treating them as separate topics,
- and prepare you for the second half of Module 2, where stellar evolution starts to matter.

What to do

Complete the assigned Practice Problems from the end of the following lecture readings:

- **Lecture 14:** Our Star: The Sun — Practice Problems
- **Lecture 15:** Measuring the Stars — Practice Problems
- **Lecture 16:** The H-R Diagram — Practice Problems
- **Lecture 17:** Binary Stars & Stellar Masses — Practice Problems

Use the lecture pages for the full problem statements (located at the end of each lecture).

Important: Do the assigned problems in the order listed below. The last four are designed as a synthesis cluster.

Notation: `P` = core problem, `C` = challenge problem in the lecture reading.

Problems to complete

1. **Lecture 14:** `P4` — Radiative vs. Convective Energy Transport
2. **Lecture 15:** `P5` — Distance Modulus
3. **Lecture 15:** `P4` — Luminosity from Distance and Brightness
4. **Lecture 15:** `C3` — An Unseen Companion
5. **Lecture 16:** `P2` — Reading the H-R Diagram
6. **Lecture 16:** `P4` — Giants vs. Dwarfs
7. **Lecture 17:** `P1` — Combined Mass of a Visual Binary
8. **Lecture 17:** `P5` — Infer Mass from Luminosity
9. **Lecture 16:** `C2` — A Mysterious Star
10. **Lecture 17:** `C4` — Why Binary-Star Masses Calibrate Single Stars

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Optional extra practice (not collected, strongly recommended)

If you want additional review after the required set:

- **Lecture 14:** `P2`, `P3`, `P5`
- **Lecture 15:** `P1`, `P3`, `C1`
- **Lecture 16:** `P3`, `P5`, `C1`
- **Lecture 17:** `P4`, `P6`, `C2`

How to earn full credit

1) Show your work (always)

For any problem with numbers, your solution must include:

- setup (what you're solving for)
- knowns/unknowns (what you're given)
- equations or reasoning path (why you're doing what you're doing)
- units at every step (units are not decoration — they're error-checking)
- a final answer that is clearly labeled (box/circle it)

If you only write a final number, you should **expect major point loss** even if it's correct.

2) Explain your reasoning (conceptual problems)

For conceptual questions, write in complete sentences. Aim for:

- Claim: your answer
- Evidence/Reasoning: why (use the lecture ideas)
- Optional sketch: a quick diagram is often worth 10 sentences

3) Use diagrams like a scientist

For geometry/sky problems: draw a labeled sketch (Sun–Earth–observer, horizon/zenith, tilt, angles). You don't need to be an artist — just be clear.

For this homework, separate what is **directly observed** from what is **inferred** whenever you are reasoning from brightness, spectra, H-R diagram position, or binary motion. On any problem using logs, powers, or ratios, show the setup line before you press buttons on a calculator.

Collaboration and resources

- You may discuss ideas with classmates, but your write-up must be your own.
- If you worked with someone, add a short line at the top of your solution PDF: "Collaborators: …"
- You may use your notes, the readings, and a calculator.

Pro tips (to save time and pain)

- Do the required problems in order. They are scaffolded on purpose.
- When you use a relation like distance modulus, Stefan-Boltzmann, or mass-luminosity, write the symbolic equation first and then substitute numbers.
- On H-R diagram problems, ask four questions in order: What do we know about temperature? luminosity? radius? mass?
- If a result feels extreme, do a quick sanity check before moving on: are the units right, and does the conclusion make sense for a **main-sequence** star or an **evolved** star?
- The final two problems are meant to feel like a capstone. Take them slowly and explain your reasoning in sentences, not just equations.

Help

If you get stuck, bring at least **one specific attempt** (a diagram, your setup, where you got lost) to office hours. Struggle is normal; *productive struggle* is the point.