ASTR 101 — Homework #6 (Lectures 18–21)

Practice problems from star formation, stellar evolution, stellar death, and compact remnants

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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: *star formation and dust • main-sequence lifetime and stellar evolution • white dwarfs and supernovae • neutron stars, black holes, and modern observational evidence*

Estimated time: ~5-6 hours

Posted: Wednesday, April 8, 2026

> **Note**
>
> Your worked solutions are due **Tuesday, April 14, 2026 at 11:59 pm PT** on Canvas, and the self-assessment grade memo is due **Friday, April 17, 2026 at 11:59 pm PT** on Canvas.

Why this homework exists (read this)

This is not busy work. This assignment is designed as a full-lifecycle review of stars: how they form, how they evolve, how they die, and what remnants they leave behind.

This assignment is designed to:

- connect Lectures 18-21 into one coherent story instead of four isolated topics,
- reinforce the Observable -> Model -> Inference chain under mixed conceptual and quantitative conditions,
- and prepare you for cumulative thinking about stellar populations, stellar remnants, and astrophysical evidence.

What to do

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

- **Lecture 18:** From Gas to Stars — Practice Problems
- **Lecture 19:** Stellar Evolution — Practice Problems
- **Lecture 20:** How Stars Die — Practice Problems
- **Lecture 21:** Neutron Stars and Black Holes — 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. They are intentionally sequenced from stellar birth to stellar death and compact remnants. The final two are designed as synthesis capstones.

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

Problems to complete

1. **Lecture 18:** `P2` — The Jeans Criterion
2. **Lecture 18:** `P5` — Observing a Hidden Protostar
3. **Lecture 19:** `P1` — Main-Sequence Lifetime Calculation
4. **Lecture 19:** `P2` — The Red-Giant Sun
5. **Lecture 19:** `P4` — Cluster Age from Main-Sequence Turnoff
6. **Lecture 20:** `P3` — Chandrasekhar Limit
7. **Lecture 20:** `P8` — Supernova Energy Budget
8. **Lecture 20:** `P9` — Type Ia vs. Type II: Observable Differences
9. **Lecture 21:** `P2` — Schwarzschild Radius
10. **Lecture 21:** `C4` — Multi-Messenger Astronomy

Optional extra practice (not collected, strongly recommended)

If you want additional review after the required set:

- **Lecture 18:** `P1`, `P3`, `P4`, `C2`
- **Lecture 19:** `P3`, `P5`, `C1`
- **Lecture 20:** `P1`, `P4`, `P6`, `P10`
- **Lecture 21:** `P1`, `P3`, `P4`, `P5`

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, clearly separate what is **observed** from what is **inferred** whenever you are reasoning from dust extinction, H-R diagram position, supernova signatures, gravitational evidence, or multi-messenger timing. On calculation problems, write the symbolic equation first, then substitute numbers, then do a unit or sanity check.

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)

- Treat this homework as one story: cloud collapse -> stellar lifetimes -> stellar death -> compact remnants.
- On star-formation problems, ask whether the key issue is **temperature**, **dust**, or **gravity**.
- On stellar-evolution problems, use mass as your organizing variable.
- On supernova and remnant problems, keep track of what astronomers actually observe before jumping to the physical interpretation.
- For the final capstone, write in sentences first and equations second. That problem is primarily about reasoning, not button pressing.

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.