ASTR 101 — Homework #3 (Lectures 6–9)

Practice problems from Lectures 6–9 (Gravity, Light, Blackbody Radiation, Spectral Lines)

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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: *Newton's laws & gravity • orbital mass • wave equation • inverse-square law for light • Wien's law • Stefan-Boltzmann law • stellar sizes • Kirchhoff's laws • hydrogen energy levels • spectral classification*

Estimated time: ~3–4 hours

Why this homework exists (read this)

This is not busy work. This assignment covers the physics of gravity and light — the two pillars you'll use for the rest of the semester. Gravity tells us about mass; light tells us about temperature, composition, and distance. Every topic from here forward builds on these ideas.

This assignment is designed to:

- build fluency with the key equations (wave equation, Wien's law, Stefan-Boltzmann law, Newton's Kepler III),
- connect observations to physical models (the Observable → Model → Inference chain),
- and prepare you for the Module 1 Exam.

What to do

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

- **Lecture 6:** Newton's Gravity — Practice Problems
- **Lecture 7:** Light as Information — Practice Problems
- **Lecture 8:** Blackbody Radiation — Practice Problems
- **Lecture 9:** Spectral Lines — Practice Problems

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

Problems to complete

Lecture 6 — Newton's Gravity

5, 6

Lecture 7 — Light as Information

1, 4

Lecture 8 — Blackbody Radiation

1, 3, 9

Lecture 9 — Spectral Lines

1, 2, 9

Optional extra practice (not collected, strongly recommended)

If you want more study problems for quiz/exam prep:

- **Lecture 6:** Try 3 (inverse-square scaling) and 10 (why $P^2 = a^3$ only works in solar units)
- **Lecture 7:** Try 3 (Rayleigh scattering) and 6 (scattering ratio calculation)
- **Lecture 8:** Try 7 (combined Wien + Stefan-Boltzmann) and 8 (Earth as a blackbody)
- **Lecture 9:** Try 4 (why H lines are weak in both O and M stars) and 7 (why not hotter?)

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, diagrams and sketches are especially helpful for the synthesis problems. Show your equation setup and unit tracking for all calculation problems — partial credit depends on seeing your reasoning.

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)

- Start with the conceptual questions first, then do the calculations.
- When stuck, ask: **"What is observable here? What is inferred?"**
- Use **units** as your lie detector.
- Do a quick sanity check: is the answer the right order of magnitude?
- For the Mystery Star problem (L9 #9): work through parts (a)–(c) in order — each part builds on the last.

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.