PMU199S LEC0341 (2018) Peet, A.W. -- selected practice questions from old exams

These will be the instructions on the front page of our exam paper:-

[bla bla bla]

Duration: 3 hours

Aids permitted: one-page letter-sized (8.5x11") personal aid sheet.

INSTRUCTIONS

There are five questions, all short-answer style.

All questions are mandatory and have equal weight.

Write in blue or black permanent ink only. Cross-outs are OK.

Explain your reasoning, to enable awarding of partial credit.

Turn your aid sheet in with your exam booklet.

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The five questions on our final exam will have two equally weighted parts each, (a) and (b).
The ten part-questions will correspond to material from Weeks 2 through 11 of our classes.

Q1: Particle Physics + Newton's Laws [20 marks]

- How did Rutherford uncover the structure of the atom? Draw a sketch to help illustrate.
- What are the four forces, and which particles are their messenger bosons?
- Use Newton's laws of motion to explain why Earth hardly moves when the professor jumps up and down during class.
- Describe the inverse square law for Newton's universal theory of gravitation.

Q2: Einstein's Refinements + GR and Black Holes [20 marks]

- What was the most surprising thing you learned about the Twin Paradox of relativity?
- Describe the phenomenon of redshift/blueshift for photons.
- How do black holes form? How can astronomers "see" them if they are black?
- Can a planet orbit around a black hole? Why or why not?

Q3: Quantum Mechanics [20 marks]

- Describe Young's famous double slit experiment showing wavelike properties of light. Include a sketch.
- What is diffraction? Why was the Davisson-Germer experiment so important for quantum mechanics?
- Explain the phenomenon of spectral lines, i.e., why photons emitted by excited atoms have specific frequencies.
- What did Albert Einstein win the Nobel Prize for explaining?

Q4: Cosmology [20 marks]

- Why is the night sky not ablaze with starlight in all directions?
- What is the Cosmic Microwave Background (CMB)? Why is it important?
- How do we know that there was a Big Bang about 13.8 billion years ago?
- Sketch a pie chart describing the composition of the energy budget of the universe. How do astrophysicists weigh the universe?

Q5: Unification + String Theory [20 marks]

- Explain the concept of unification. Give an example.
- Could there be extra dimensions of space? Draw a sketch.
- How does string theory heal sicknesses of general relativity at ultra-short distances?
- Explain how photons and gravitons are both naturally included within superstring theory. (Hint: superstrings can be open or closed.)