

Oberlin College Physics 212, Fall 2021 semester

Final Exam Information

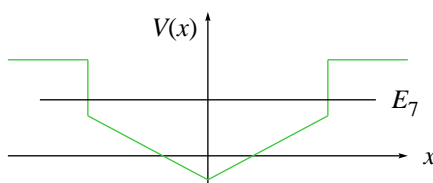
Wednesday, 12 January 2022

The final exam for this course will be a two-hour limited-time open-book open-notes open-Internet take-home exam due at 4:00 PM on Friday, 21 January 2022.

Topics: There will be eight questions. I think there will be two on relativity, two on classical waves, and four on quantum mechanics and nuclear physics, but I'm not sure.

Sample exam: To give you an idea of what to expect, here is a sample exam.

1. Sketch the seventh energy eigenfunction for the potential below.



2. Is the nucleus $^{12}_5\text{B}$ stable or unstable to beta decay? If unstable, how does it decay? Explain how you know. (*Partial answer:* Unstable. $^{12}_5\text{B} \rightarrow ^{12}_6\text{C} + e^- + \bar{\nu}$.)
3. Light of wavelength λ is incident on three parallel slits, with distance a between adjacent slits. In terms of the angle θ , what is the criterion for complete constructive interference? (*Answer:* $a \sin \theta = m\lambda$ for $m = 0, \pm 1, \pm 2, \dots$.)
4. The bright yellow light in the spectrum of sodium has wavelength 589 nm. What is the energy of such a photon? (*Answer:* 2.10 eV; three significant figures.)
5. A free electron is said to absorb a photon. Do you believe this claim? Support your answer. (*Partial answer:* No... relativistic energy and momentum cannot both be conserved.)
6. The hydrogen atom state $|1s\rangle$ has energy $-Ry$, the state $|2p\rangle$ has energy $-\frac{1}{4}Ry$. A hydrogen atom starts off in state $\frac{4}{5}|1s\rangle + \frac{3}{5}|2p\rangle$. How much time elapses before the atom returns to this initial state? (*Answer:* $(2\pi\hbar)/(\frac{3}{4}Ry)$.)
7. Electrons pass through two slits separated by 3.68 nm and result in interference maxima separated by 2.57 degrees. What was the momentum of the incoming electrons? Use whichever units you find most appropriate. (*Answer:* 4.02×10^{-24} kg·m/s.)
8. A train passes us at such high speed that we observe the passengers having one heartbeat every 27 seconds. Normally, such slow heart rates would be cause for medical concern. However, the passengers seem perfectly healthy. Why aren't their cells desperate for more oxygen? (*Answer:* Their cells are respiring slowly, too.)