Physics 60 Exam 1 - Front page
10:30 - 11:35am Wed Oct4

You may use a 3"x5" card of notes, both sides. No calculators. No phones.

There is no acceptable reason for your work to look exactly like someone else's work.

"Someone else" includes other people, the textbook, anything on the web, and handed out solutions.

Present clear and complete solutions

Start solutions with definitions (e.g. $\vec{v} \equiv \frac{d\vec{r}}{dt}$), theorems (e.g. Newton's laws), and commonly used equations (e.g. constant acceleration equations).

Any physics/engineering major should be able to understand what you did just by reading your solution. A diagram and words usually help. A correct final answer without a reasonably organized justification will earn no credit.

Leave some values and integrals uncalculated.

Do all derivatives.

Do simple integrals: $\int \mathrm{a} z^n dz$, $\int \mathrm{a} e^x dx$, $\int \mathrm{a}(\cos\theta) d\theta$, $\int \mathrm{a}(\sin\phi) d\phi$, and $\int \mathrm{a}\ln(g) dg$.

Leave other integrals unintegrated. Include the limits of integration, move constants out of the integral, and simplify.

Do simple calculations: (1) multiply, divide, subtract and add integers with powers of 10, (2) simple fractions and square roots, and (3) sine and cosine of common angles such as $0, \pi, \pi/4, \pi/3, \ldots$.

Leave other calculations uncalculated. Provide an expression that requires a single calculation from your calculator. This means using the correct units.

Make-up exams will be arranged if you can provide (1) an approved and documentable excuse **and** (2) advance notice (an email or voicemail 30 minutes ahead of time is fine). If you cannot do **both**, you cannot make up the exam.

Physics 60 Exam 1 - Review sheet

1. What is the speed of light in all reference frames?

2. Define an "event."

   Give an example of something that is an event. Give an example of something that isn't an event.

3. Given an event in an inertial reference frame, describe that same event in another inertial frame.

   Use the (a) Lorentz and
   (b) Galilean transformations.

4. Consider a chronological set of events. Retell this same set of events from another reference frame.

5. Derive the equation for time dilation, $\Delta t' = \gamma_v \Delta t$.

   Start with the idea that Δt is an interval between two different events. Then transform each of these events into the other reference frame.

6. The velocity of an object is measured by frame S'. Determine the velocity of this object in S. (And the reverse.)

7. What are the values of β and γ in the limit that $\frac{v}{c} \ll 1$? $\frac{v}{c} = 1$?

8. (a) Show that the classical transformations for time, spatial position and velocity can be recovered from the relativistic transformations in the limit that $\frac{v}{c} \ll 1$.

   (b) Show that the classical expressions for momentum and kinetic energy can be recovered from the relativistic expressions in the appropriate limit. (What is that limit?)

9. A particle has velocity and mass. Calculate its

   (a) momentum

   (b) rest, kinetic and total energies.

10. Calculate the (change in) energy associated with the (change in) mass of an object. And the reverse.

11. In collisions, fissions and scattering

    (a) calculate initial and final velocities, momenta, and energies.

    (b) show that energy and momentum are conserved in any reference frame. Give an explicit calculation.

    (c) determine if mass is conserved. Give an explicit calculation.

12. (a) Calculate the space-time interval between two events.

    (b) Determine whether the interval is timelike, spacelike, or lightlike.

    (c) Explain the physical significance of being timelike or spacelike.

    (d) What does this have to do with causality?

13. What is the difference between *invariant* and *conserved*?

    Give an example of a quantity that's conserved, but not invariant. A quantity that isn't conserved, but is invariant?

14. Calculate an invariant quantity associated with the

    (a) space-time vector, and

    (b) energy-momentum vector.

    (c) Show, using explicit calculations, that it is an invariant quantity.

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15. (a) What is blackbody radiation? Use text, a diagram and an equation.

    (b) Calculate the peak wavelength (or frequency) of a blackbody at a particular temperature.

16. What is the photoelectric effect?

    (a) Describe the experiment and the resulting observations. Use text and a diagram.
    (b) What should be observed if light were strictly a wave?
    (c) Explain the results of the photoelectric effect using photons. Use text and an equation.
    (d) Calculate the work function of a metal, the maximum kinetic energy of the emitted electrons, or the wavelength of the incident light.

17. Consider a photon. Determine its

    (a) speed, frequency and wavelength
    (b) energy and momentum

18. Consider a source of light with wavelength λ and power P. Determine

    (a) its intensity, when given an area
    (b) the number of photons per second that emanate from the source

19. (a) Describe how x-rays are produced. Use text and a diagram.

    (b) What is the threshold wavelength? Why aren't x-rays produced with wavelengths smaller than the threshold wavelength?

20. (a) Describe the Compton scattering experiment. Describes the experimental observations from this experiment. Use text and a diagram.

    (b) Outline how to arrive at the Compton scattering formula ($\lambda' - \lambda = \ldots$). Include significant starting equations and assumptions. There is no need to *do* the derivation, but explain each starting equation.

21. Consider collisions, fissions and scattering of photons and subatomic particles (electrons, neutrons, ...). Calculate

    (a) initial and final velocities of the particles
    (b) initial and final masses of the particles
    (c) incident and scattered photon energies and momenta