

Essential Knowledge Questions used for Program Assessment

Below is a list of example Essential Knowledge Questions (EKQs) that will be used to test student knowledge regarding essential knowledge that physics faculty have determined as necessary for all physics B.S. graduates. Student performance will be used as data for the department's yearly program assessment. This list will be expanded as more EKQs are developed.

Electromagnetism

- Let's say that a student in PHSX 423 is asked to calculate the electric field for an infinite disc of charge, yielding $E = \sigma/2\epsilon_0$. The associated EKQ might ask, Your result should have revealed that $E = \sigma/2\epsilon_0$, show that the units of E are volts per meter., thereby testing the Essential Knowledge category - dimensional analysis.
- Imagine that a 1 cm thick plate of copper with no net electric charge is placed in a static, uniform electric field E with the field lines passing perpendicular to the plate's surface. Sketch the distribution of electric charge on the plate, and state the net electric field at the surfaces and inside of the plate.
- Write down the Poynting vector in terms of electric and magnetic fields. From that expression, determine the units of the Poynting vector.
- Can an electromagnetic wave propagate in a perfect conductor? Explain.
- Why is the sky blue?
- A conducting ring of radius a has resistance R and lies in the xy plane. An experimenter creates an oscillating magnetic field $\mathbf{B} = B_0 \cos(\omega t) \hat{z}$. Determine how much work the experimenter must do per cycle. Supposedly magnetic fields do no work. How is the work being done?
- Waves in some material follow the dispersion relation $\omega = ck - bk^2$, where ω is the angular frequency, k is the wave number, and c and b are positive constants. Determine the wave number at which the group velocity vanishes. Determine the wave number at which the phase velocity vanishes.

Thermodynamics and Statistical Physics

- System A has two possible energy levels and System B has 3. The two systems are coupled through thermal conduction. What is the entropy of the entire system?

- Sketch the specific heat versus inverse temperature for a two-level system.
- Why does the temperature of the atmosphere decrease with height (on average).
- A particle scatters with target particles in Medium A. In Medium B, both the target density and the cross section are twice their values of Medium A. How do the mean-free-paths compare in the two media?

Quantum Mechanics

Classical Mechanics

- A particle of mass m moves in the 1-d potential: $V(x)=ax + c/x$, where a and c are positive constants. Determine the frequency of small oscillations about the minimum in the potential.
- A particle of mass m moves in the 1-d potential: $V(x)=ax + c/x$, where a and c are positive constants. The particle is also subject to a damping force $-bx$, where b is a constant. How could we choose the values of a and c that will make the particle damp to equilibrium as fast as possible? Extra credit: derive your result from the equation of motion.

Mathematical Physics

- Sketch $e^{-x} \sin(x)$.
- A wire carries a current pulse of duration Δt . What is the approximate width of the pulse in frequency space?

Electronics