Name: _____ **Date:** _____

Answer Key: Neon Flux Expedition: 11th Grade Quantum & Relativistic Mechanics Quest

Calculate spacetime distortions and orbital probability densities that challenge the deterministic clockwork of classical physics.

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1. A Muon, a subatomic particle with a lifespan of 2.2 microseconds at rest, is detected reaching Earth's surface after traveling through the atmosphere at 0.994c. What relativistic phenomenon explains its survival over this distance?

Answer: B) Time dilation

From the Earth's frame, the muon's internal clock slows down due to its velocity (time dilation), allowing it to survive long enough to reach the surface before decaying.

2. In the context of the Copenhagen interpretation, the _____ principle asserts that certain pairs of physical properties, like position and momentum, cannot be simultaneously known with infinite precision.

Answer: C) Uncertainty

Heisenberg's Uncertainty Principle is a fundamental limit in quantum mechanics, stating the product of the uncertainties of position and momentum is at least h-bar divided by two.

3. According to General Relativity, a clock positioned at the base of a high-mass mountain will tick slightly slower than an identical clock at the mountain's peak.

Answer: A) True

Gravitational time dilation dictates that time passes more slowly in stronger gravitational fields (closer to the center of mass).

4. If you double the intensity of monochromatic light hitting a metal surface in a photoelectric experiment without changing the frequency, what occurs?

Answer: C) The number of electrons ejected per second doubles.

Intensity corresponds to the number of photons; higher intensity means more photon-electron collisions, increasing current but not individual electron energy.

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5. When a high-energy photon collides with a stationary electron and scatters at an angle, transferring some of its energy, the resulting increase in wavelength is known as the _____ Shift.

Answer: B) Compton

The Compton Effect demonstrates the particle-like behavior of light, where momentum conservation leads to a shift in wavelength after scattering.

6. In the standard model of cosmology, the 'Event Horizon' of a black hole represents:

Answer: B) The boundary where escape velocity exceeds the speed of light.

The Event Horizon is the 'point of no return' defined by General Relativity where even light cannot escape the gravitational pull.

7. The de Broglie hypothesis suggests that a macroscopic object, like a flying baseball, does not have a measurable wavelength because its mass is too high.

Answer: A) True

While everything has a de Broglie wavelength ($\lambda = h/mv$), the large mass of macroscopic objects makes the wavelength so small it is undetectable and physically negligible.

8. Einstein's principle of _____ states that an observer in a sealed elevator cannot distinguish between being accelerated upwards and being in a uniform gravitational field.

Answer: C) Equivalence

The Equivalence Principle is the bedrock of General Relativity, linking inertial acceleration to gravitational force.

9. What does the squared magnitude of the wave function ($|\psi|^2$) represent in the Schrödinger formulation of quantum mechanics?

Answer: B) The probability density of finding a particle at a specific location.

Unlike classical orbits, quantum particles are described by probability distributions; the squared wave function provides the likelihood of detection in a given volume.

10. The 'Twin Paradox' is resolved by recognizing that the twin who travels to space and returns is the one who undergoes non-inertial acceleration, breaking the symmetry of the frames.

Answer: A) True

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Special Relativity applies to inertial frames; the traveling twin must accelerate and decelerate, meaning they do not stay in a single inertial frame, which accounts for the age difference.