Name: _____ **Date:** _____

Answer Key: Why Aging in Space Isn't Science Fiction: 11th Grade Physics

Students calculate relativistic shifts and analyze quantum behaviors to synthesize how microscopic events reshape our macroscopic reality.

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1. A muon is an unstable subatomic particle that decays very quickly. Even though its lifespan should be too short to reach the Earth's surface from the upper atmosphere, we detect them at sea level. Which concept explains this?

Answer: B) Time dilation due to high-velocity travel

From the Earth's frame of reference, the muon's internal 'clock' slows down because it is moving at relativistic speeds, allowing it to travel further before decaying.

2. According to General Relativity, a clock positioned at the top of a skyscraper will tick slightly faster than a clock located in the basement.

Answer: A) True

Gravitational time dilation dictates that time passes more slowly in stronger gravitational fields (closer to the Earth's center).

3. To satisfy the conservation laws in modern physics, if a particle of matter meets its corresponding antimatter particle, they undergo _____.

Answer: B) Total annihilation into energy

When matter and antimatter collide, their entire mass is converted into energy (usually gamma-ray photons) following $E=mc^2$.

4. The scanning tunneling microscope (STM) allows scientists to see individual atoms. This technology relies on which quantum phenomenon?

Answer: C) Quantum Tunneling

Quantum tunneling allows electrons to pass through a vacuum barrier between the microscope tip and the sample, a feat impossible in classical physics.

5. If an object moves at 99% the speed of light, its mass remains exactly the same as its rest mass regardless of the observer's frame.

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Answer: B) False

Relativistic momentum increases as an object approaches light speed; in many pedagogical contexts, this is interpreted as an increase in 'relativistic mass' relative to the observer.

6. Louis de Broglie proposed that if light waves can behave like particles, then matter (like electrons) can behave like _____.

Answer: A) Waves

De Broglie's hypothesis of wave-particle duality applies to all matter, suggesting that moving particles have an associated wavelength.

7. Which of these provides the most direct evidence that energy is quantized rather than continuous?

Answer: B) The discrete emission spectra of gases

Discrete spectral lines show that electrons only transition between specific, fixed energy levels, emitting light in specific 'quanta' or packets.

8. The Heisenberg Uncertainty Principle suggests that measuring the velocity of an electron with extreme precision inherently makes its position less certain.

Answer: A) True

The principle states that the product of the uncertainties in position and momentum is always greater than or equal to a constant ($h/4\pi$).

9. In the context of General Relativity, the region around a massive object where even light cannot escape is bounded by the _____.

Answer: C) Event Horizon

The event horizon is the 'point of no return' where the escape velocity exceeds the speed of light.

10. If you observe a 100-meter long spaceship flying past you at 0.8c, what will you measure its length to be?

Answer: C) Less than 100 meters

Length contraction occurs in the direction of motion for objects moving at relativistic speeds as seen by a stationary observer.