**Wave particle duality quiz version D**

1. An *observer is present* is the fourth segment of [*Wave-particle duality.ogv*](https://en.wikiversity.org/wiki/File%3AWave-particle_duality.ogv). This observer disrupts the diffraction pattern because:

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|  | a) While all of these arguments have been used, the validity of some are **"**[**uncertain**](http://arxiv.org/pdf/1208.0034.pdf)**"**(pun intended). |
|  | b) If [**Heisenberg's microscope**](https://en.wikipedia.org/wiki/Heisenberg%27s_microscope) is used to ascertain which slit has the particle, the wavelength required to obtain sufficient resolution implies that the photons have sufficient individual momentum to "kick" the particle out of its original path. |
|  | c) By the [uncertainty principle](https://en.wikipedia.org/wiki/uncertainty_principle), knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion. |
|  | d) By the [Copenhagen interpretation](https://en.wikipedia.org/wiki/Copenhagen_interpretation), knowing that the particle is in one slit destroys the wavefunction at the other slit. |

2. The first (*particle*) segment in [*Wave-particle duality.ogv*](https://en.wikiversity.org/wiki/File%3AWave-particle_duality.ogv) does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.

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|  | a) true |
|  | b) false |

3. A ["spooky"](https://en.wikiversity.org/wiki/Quantum_mechanics_timeline#Taylor_makes_things_spooky_with_very_dim_light_in_1909) variation of the third (*quantum*) segment of [*Wave-particle duality.ogv*](https://en.wikiversity.org/wiki/File%3AWave-particle_duality.ogv) occurs when the signal is so weak that only one particle is usually near the slit at any given time. This experiment was first performed by

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|  | a) [Davisson and Germer](https://en.wikipedia.org/wiki/Davisson%E2%80%93Germer_experiment) in 1925. |
|  | b) [Taylor](https://en.wikipedia.org/wiki/G._I._Taylor) in 1909. |
|  | c) [Aspect](https://en.wikipedia.org/wiki/Alain_Aspect) in 1982. |
|  | d) [Young](https://en.wikipedia.org/wiki/Young%27s_interference_experiment) in 1801. |
|  | e) [Newton](https://en.wikipedia.org/wiki/Opticks) in 1704. |

4. The (*wave*) second segment of [*Wave-particle duality.ogv*](https://en.wikiversity.org/wiki/File%3AWave-particle_duality.ogv) is based on the fact that the two waves emanating from the two slits can [interfere](https://en.wikipedia.org/wiki/Interference_%28wave_propagation%29) with each other.

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|  | a) true |
|  | b) false |

5. A dead "fly" of mass is placed in a dark gravity-free vacuum, somewhere not too far from the origin. The speed of the fly is known to be zero with virtually zero uncertainty. To ascertain the fly's position you construct "flyswatter" that can detect any collision between the flyswatter" and fly. A small hole of radius in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [uncertainty](https://en.wikipedia.org/wiki/uncertainty_principle) that can be calculated from:

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|  | a)  \Delta v \cdot \Delta x \geq \frac{m\hbar}{2} |
|  | b)  \Delta v \cdot \Delta x \leq \frac{m\hbar}{2} |
|  | c)  m\Delta v \cdot \Delta x \geq \frac{\hbar}{2} |
|  | d)  m\Delta v \cdot \Delta x \leq \frac{\hbar}{2} |

6. An understanding of the diffraction pattern associated with particles is based on

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|  | a) Forces that the De Broglie [pilot wave](https://en.wikipedia.org/wiki/pilot_wave) exert between pairs of particles. |
|  | b) Forces that the De Broglie [pilot wave](https://en.wikipedia.org/wiki/pilot_wave) exert on individual particles. |
|  | c) The fact that particles can make glancing collisions with the edge of a slit. |
|  | d) [Interference](https://en.wikipedia.org/wiki/Interference_%28wave_propagation%29) between the component of the wave from each slit. |
|  | e) All of these nearly equivalent models explain diffraction. |

7. The first (*particle*) segment in [*Wave-particle duality.ogv*](https://en.wikiversity.org/wiki/File%3AWave-particle_duality.ogv) does not depict a diffraction pattern when particles impinge upon two slits because [classical (Newtonian)](https://en.wikipedia.org/wiki/Classical_physics) physics fails to predict such diffraction.

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|  | a) true |
|  | b) false |

8. Observe the second (*wave*) segment of [*Wave-particle duality.ogv*](https://en.wikiversity.org/wiki/File%3AWave-particle_duality.ogv) and note the rapid divergence of the wave at each of the two slits (better seen [**here**](https://en.wikiversity.org/wiki/File%3ADoubleslit3Dspectrum.gif)). This occurs because significant [single slit diffraction](https://en.wikipedia.org/wiki/Diffraction#Single-slit_diffraction) occurs for a slit that is sufficiently wide.

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|  | a) true |
|  | b) false |

9. Observe the second (*wave*) segment of [*Wave-particle duality.ogv*](https://en.wikiversity.org/wiki/File%3AWave-particle_duality.ogv) and note the rapid divergence of the wave at each of the two slits (better seen [**here**](https://en.wikiversity.org/wiki/File%3ADoubleslit3Dspectrum.gif)). This occurs because significant [single slit diffraction](https://en.wikipedia.org/wiki/Diffraction#Single-slit_diffraction) occurs for a slit that is sufficiently narrow.

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|  | a) true |
|  | b) false |

10. The second (*wave*) segment of [*Wave-particle duality.ogv*](https://en.wikiversity.org/wiki/File%3AWave-particle_duality.ogv) depicts a two slit diffraction pattern that is modeled by a formula put forth by

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|  | a) [Heisenberg](https://en.wikipedia.org/wiki/Werner_Heisenberg#G.C3.B6ttingen.2C_Copenhagen.2C_and_Leipzig) in 1925. |
|  | b) [Newton](https://en.wikipedia.org/wiki/Opticks) in 1704. |
|  | c) [Young](https://en.wikipedia.org/wiki/Young%27s_interference_experiment) in 1801. |
|  | d) [Taylor](https://en.wikipedia.org/wiki/G._I._Taylor) in 1909. |
|  | e) [Schroedinger](https://en.wikipedia.org/wiki/Erwin_Schrodinger#Creation_of_wave_mechanics) in 1926. |