== Wave particle duality quiz version B ==

<quiz display=simple>

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

+c) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-d) The fact that particles can make glancing collisions with the edge of a slit.

-e) All of these nearly equivalent models explain diffraction.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:G. I. Taylor| Taylor]] in 1909.

+b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+b) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-c) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

-d) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+b) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-d) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Young's interference experiment|Young]] in 1801.

-b) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

+c) [[w:G. I. Taylor| Taylor]] in 1909.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Alain Aspect|Aspect]] in 1982.

</quiz>

== Wave particle duality quiz version C ==

<quiz display=simple>

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-b) [[w:Opticks|Newton]] in 1704.

+c) [[w:Young's interference experiment|Young]] in 1801.

-d) [[w:G. I. Taylor| Taylor]] in 1909.

-e) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

+b) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-c) By the [[w:uncertainty principle|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 [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

+b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Opticks|Newton]] in 1704.

-d) [[w:Alain Aspect|Aspect]] in 1982.

-e) [[w:Young's interference experiment|Young]] in 1801.

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

+c) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-d) The fact that particles can make glancing collisions with the edge of a slit.

-e) All of these nearly equivalent models explain diffraction.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+c) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

</quiz>

== Wave particle duality quiz version D ==

<quiz display=simple>

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

+a) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-b) If '''[[w:Heisenberg's microscope|Heisenberg's 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 [[w:uncertainty principle|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 [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

+b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Alain Aspect|Aspect]] in 1982.

-d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Opticks|Newton]] in 1704.

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

+c) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-d) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-c) The fact that particles can make glancing collisions with the edge of a slit.

+d) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-e) All of these nearly equivalent models explain diffraction.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-b) [[w:Opticks|Newton]] in 1704.

+c) [[w:Young's interference experiment|Young]] in 1801.

-d) [[w:G. I. Taylor| Taylor]] in 1909.

-e) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

</quiz>

== Wave particle duality quiz version E ==

<quiz display=simple>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Opticks|Newton]] in 1704.

-c) [[w:Alain Aspect|Aspect]] in 1982.

-d) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-e) [[w:Young's interference experiment|Young]] in 1801.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-b) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-c) [[w:G. I. Taylor| Taylor]] in 1909.

+d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Opticks|Newton]] in 1704.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

+a) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-d) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-b) The fact that particles can make glancing collisions with the edge of a slit.

+c) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-e) All of these nearly equivalent models explain diffraction.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

+a) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-b) If '''[[w:Heisenberg's microscope|Heisenberg's 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 [[w:uncertainty principle|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 [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

</quiz>

== Wave particle duality quiz version F ==

<quiz display=simple>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+c) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) All of these nearly equivalent models explain diffraction.

+b) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-e) The fact that particles can make glancing collisions with the edge of a slit.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+b) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-c) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

+b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:G. I. Taylor| Taylor]] in 1909.

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Opticks|Newton]] in 1704.

-c) [[w:Alain Aspect|Aspect]] in 1982.

-d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

</quiz>

== Wave particle duality quiz version G ==

<quiz display=simple>

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Alain Aspect|Aspect]] in 1982.

-b) [[w:Opticks|Newton]] in 1704.

-c) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

+d) [[w:G. I. Taylor| Taylor]] in 1909.

-e) [[w:Young's interference experiment|Young]] in 1801.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

+b) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-d) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:G. I. Taylor| Taylor]] in 1909.

+b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-d) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-e) [[w:Opticks|Newton]] in 1704.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

-b) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+c) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

+a) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-b) All of these nearly equivalent models explain diffraction.

-c) The fact that particles can make glancing collisions with the edge of a slit.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

</quiz>

== Wave particle duality quiz version H ==

<quiz display=simple>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-c) [[w:Young's interference experiment|Young]] in 1801.

-d) [[w:Alain Aspect|Aspect]] in 1982.

-e) [[w:Opticks|Newton]] in 1704.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+d) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

{An understanding of the diffraction pattern associated with particles is based on}

-a) The fact that particles can make glancing collisions with the edge of a slit.

-b) All of these nearly equivalent models explain diffraction.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

+e) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-b) If '''[[w:Heisenberg's microscope|Heisenberg's 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) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-b) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-c) [[w:Opticks|Newton]] in 1704.

+d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:G. I. Taylor| Taylor]] in 1909.

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

</quiz>

== Wave particle duality quiz version I ==

<quiz display=simple>

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Alain Aspect|Aspect]] in 1982.

-c) [[w:Opticks|Newton]] in 1704.

-d) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-e) [[w:Young's interference experiment|Young]] in 1801.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) All of these nearly equivalent models explain diffraction.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

+d) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-e) The fact that particles can make glancing collisions with the edge of a slit.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

+b) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-c) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-b) [[w:Opticks|Newton]] in 1704.

-c) [[w:G. I. Taylor| Taylor]] in 1909.

+d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+b) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-c) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

</quiz>

== Wave particle duality quiz version J ==

<quiz display=simple>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) All of these nearly equivalent models explain diffraction.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-c) The fact that particles can make glancing collisions with the edge of a slit.

+d) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-b) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-c) [[w:G. I. Taylor| Taylor]] in 1909.

-d) [[w:Opticks|Newton]] in 1704.

+e) [[w:Young's interference experiment|Young]] in 1801.

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-b) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

+c) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-b) [[w:Alain Aspect|Aspect]] in 1982.

+c) [[w:G. I. Taylor| Taylor]] in 1909.

-d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Opticks|Newton]] in 1704.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

+b) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-c) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

</quiz>

== Wave particle duality quiz version K ==

<quiz display=simple>

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

+b) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-c) The fact that particles can make glancing collisions with the edge of a slit.

-d) All of these nearly equivalent models explain diffraction.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Alain Aspect|Aspect]] in 1982.

-b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

+d) [[w:G. I. Taylor| Taylor]] in 1909.

-e) [[w:Opticks|Newton]] in 1704.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-b) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

+c) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-b) If '''[[w:Heisenberg's microscope|Heisenberg's 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 [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

+d) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Opticks|Newton]] in 1704.

+b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-d) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-e) [[w:G. I. Taylor| Taylor]] in 1909.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

</quiz>

== Wave particle duality quiz version L ==

<quiz display=simple>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

+a) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-b) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-c) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Opticks|Newton]] in 1704.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

+d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Opticks|Newton]] in 1704.

-b) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

+c) [[w:G. I. Taylor| Taylor]] in 1909.

-d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Alain Aspect|Aspect]] in 1982.

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-b) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+d) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-b) The fact that particles can make glancing collisions with the edge of a slit.

-c) All of these nearly equivalent models explain diffraction.

+d) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

</quiz>

== Wave particle duality quiz version M ==

<quiz display=simple>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

+a) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-d) All of these nearly equivalent models explain diffraction.

-e) The fact that particles can make glancing collisions with the edge of a slit.

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-b) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+c) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

+d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Opticks|Newton]] in 1704.

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-b) [[w:Alain Aspect|Aspect]] in 1982.

-c) [[w:Young's interference experiment|Young]] in 1801.

-d) [[w:Opticks|Newton]] in 1704.

+e) [[w:G. I. Taylor| Taylor]] in 1909.

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-b) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

+d) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

</quiz>

== Wave particle duality quiz version N ==

<quiz display=simple>

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Opticks|Newton]] in 1704.

-d) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

+e) [[w:Young's interference experiment|Young]] in 1801.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

+d) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-b) If '''[[w:Heisenberg's microscope|Heisenberg's 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) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-c) [[w:Opticks|Newton]] in 1704.

-d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Alain Aspect|Aspect]] in 1982.

{An understanding of the diffraction pattern associated with particles is based on}

+a) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-c) The fact that particles can make glancing collisions with the edge of a slit.

-d) All of these nearly equivalent models explain diffraction.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

</quiz>

== Wave particle duality quiz version O ==

<quiz display=simple>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

+a) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-d) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-c) [[w:Opticks|Newton]] in 1704.

-d) [[w:Alain Aspect|Aspect]] in 1982.

-e) [[w:Young's interference experiment|Young]] in 1801.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) All of these nearly equivalent models explain diffraction.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

+c) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-e) The fact that particles can make glancing collisions with the edge of a slit.

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-b) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+c) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

+a) [[w:Young's interference experiment|Young]] in 1801.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

</quiz>

== Wave particle duality quiz version P ==

<quiz display=simple>

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-d) [[w:Opticks|Newton]] in 1704.

+e) [[w:Young's interference experiment|Young]] in 1801.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-b) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-c) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

+d) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-c) [[w:Young's interference experiment|Young]] in 1801.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Alain Aspect|Aspect]] in 1982.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+c) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-b) All of these nearly equivalent models explain diffraction.

+c) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-d) The fact that particles can make glancing collisions with the edge of a slit.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

</quiz>

== Wave particle duality quiz version Q ==

<quiz display=simple>

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

+c) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-d) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) All of these nearly equivalent models explain diffraction.

-b) The fact that particles can make glancing collisions with the edge of a slit.

+c) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

+b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:G. I. Taylor| Taylor]] in 1909.

-d) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-e) [[w:Opticks|Newton]] in 1704.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Alain Aspect|Aspect]] in 1982.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-b) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+c) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

</quiz>

== Wave particle duality quiz version R ==

<quiz display=simple>

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Opticks|Newton]] in 1704.

-b) [[w:Alain Aspect|Aspect]] in 1982.

-c) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-d) [[w:Young's interference experiment|Young]] in 1801.

+e) [[w:G. I. Taylor| Taylor]] in 1909.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+b) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-c) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

-d) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

+a) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-d) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{An understanding of the diffraction pattern associated with particles is based on}

+a) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-b) All of these nearly equivalent models explain diffraction.

-c) The fact that particles can make glancing collisions with the edge of a slit.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Opticks|Newton]] in 1704.

-b) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

+c) [[w:Young's interference experiment|Young]] in 1801.

-d) [[w:G. I. Taylor| Taylor]] in 1909.

-e) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

</quiz>

== Wave particle duality quiz version S ==

<quiz display=simple>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-b) The fact that particles can make glancing collisions with the edge of a slit.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

+d) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-e) All of these nearly equivalent models explain diffraction.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

+b) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-c) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

-d) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Opticks|Newton]] in 1704.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

+d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-b) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+d) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-b) [[w:Young's interference experiment|Young]] in 1801.

+c) [[w:G. I. Taylor| Taylor]] in 1909.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Alain Aspect|Aspect]] in 1982.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

</quiz>

== Wave particle duality quiz version T ==

<quiz display=simple>

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+b) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-c) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

{An understanding of the diffraction pattern associated with particles is based on}

-a) The fact that particles can make glancing collisions with the edge of a slit.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-c) All of these nearly equivalent models explain diffraction.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

+e) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Alain Aspect|Aspect]] in 1982.

+b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Opticks|Newton]] in 1704.

-d) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-e) [[w:Young's interference experiment|Young]] in 1801.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Opticks|Newton]] in 1704.

-d) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

+e) [[w:Young's interference experiment|Young]] in 1801.

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-b) If '''[[w:Heisenberg's microscope|Heisenberg's 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 [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

+d) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

</quiz>

== Wave particle duality quiz version U ==

<quiz display=simple>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

+d) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Young's interference experiment|Young]] in 1801.

-b) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-c) [[w:Alain Aspect|Aspect]] in 1982.

+d) [[w:G. I. Taylor| Taylor]] in 1909.

-e) [[w:Opticks|Newton]] in 1704.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

+b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-d) [[w:G. I. Taylor| Taylor]] in 1909.

-e) [[w:Opticks|Newton]] in 1704.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+b) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-c) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-b) All of these nearly equivalent models explain diffraction.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

+d) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-e) The fact that particles can make glancing collisions with the edge of a slit.

</quiz>

== Wave particle duality quiz version V ==

<quiz display=simple>

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-c) [[w:Young's interference experiment|Young]] in 1801.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Alain Aspect|Aspect]] in 1982.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Opticks|Newton]] in 1704.

+b) [[w:Young's interference experiment|Young]] in 1801.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-d) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-e) [[w:G. I. Taylor| Taylor]] in 1909.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-b) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

+c) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

-b) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-c) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

+d) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

+a) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-b) The fact that particles can make glancing collisions with the edge of a slit.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-d) All of these nearly equivalent models explain diffraction.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

</quiz>

== Wave particle duality quiz version W ==

<quiz display=simple>

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

+a) [[w:Young's interference experiment|Young]] in 1801.

-b) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-c) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-d) [[w:G. I. Taylor| Taylor]] in 1909.

-e) [[w:Opticks|Newton]] in 1704.

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-b) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

+c) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

+a) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-b) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{An understanding of the diffraction pattern associated with particles is based on}

+a) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-b) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-d) The fact that particles can make glancing collisions with the edge of a slit.

-e) All of these nearly equivalent models explain diffraction.

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Opticks|Newton]] in 1704.

+b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Alain Aspect|Aspect]] in 1982.

-d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

</quiz>

== Wave particle duality quiz version X ==

<quiz display=simple>

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-d) [[w:Opticks|Newton]] in 1704.

+e) [[w:Young's interference experiment|Young]] in 1801.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Opticks|Newton]] in 1704.

-b) [[w:Alain Aspect|Aspect]] in 1982.

+c) [[w:G. I. Taylor| Taylor]] in 1909.

-d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

{An understanding of the diffraction pattern associated with particles is based on}

-a) All of these nearly equivalent models explain diffraction.

+b) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

-e) The fact that particles can make glancing collisions with the edge of a slit.

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-b) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

+c) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-d) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

-b) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-c) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

+d) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

</quiz>

== Wave particle duality quiz version Y ==

<quiz display=simple>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

+a) [[w:G. I. Taylor| Taylor]] in 1909.

-b) [[w:Alain Aspect|Aspect]] in 1982.

-c) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Young's interference experiment|Young]] in 1801.

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

-a) [[w:Opticks|Newton]] in 1704.

-b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

+d) [[w:Young's interference experiment|Young]] in 1801.

-e) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

-a) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

+b) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{An understanding of the diffraction pattern associated with particles is based on}

-a) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

+b) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-c) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-d) All of these nearly equivalent models explain diffraction.

-e) The fact that particles can make glancing collisions with the edge of a slit.

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) By the [[w:uncertainty principle|uncertainty principle]], knowing that the particle is near one slit constitutes a measurement that causes uncertainty in the particle's future motion.

-b) By the [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

+c) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-d) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

</quiz>

== Wave particle duality quiz version Z ==

<quiz display=simple>

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because particles are never observed to exhibit diffraction.}

-a) true

+b) false

{A [[Quantum\_mechanics\_timeline#Taylor\_makes\_things\_spooky\_with\_very\_dim\_light\_in\_1909|"spooky"]] variation of the third (''quantum'') segment of ''[[:File:Wave-particle duality.ogv|Wave-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}

-a) [[w:Alain Aspect|Aspect]] in 1982.

+b) [[w:G. I. Taylor| Taylor]] in 1909.

-c) [[w:Young's interference experiment|Young]] in 1801.

-d) [[w:Opticks|Newton]] in 1704.

-e) [[w:Davisson–Germer\_experiment|Davisson and Germer]] in 1925.

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently narrow.}

+a) true

-b) false

{The second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' depicts a two slit diffraction pattern that is modeled by a formula put forth by}

+a) [[w:Young's interference experiment|Young]] in 1801.

-b) [[w:Werner\_Heisenberg#G.C3.B6ttingen.2C\_Copenhagen.2C\_and\_Leipzig|Heisenberg]] in 1925.

-c) [[w:G. I. Taylor| Taylor]] in 1909.

-d) [[w:Erwin\_Schrodinger#Creation\_of\_wave\_mechanics|Schroedinger]] in 1926.

-e) [[w:Opticks|Newton]] in 1704.

{An understanding of the diffraction pattern associated with particles is based on}

+a) [[w:Interference (wave propagation)|Interference]] between the component of the wave from each slit.

-b) All of these nearly equivalent models explain diffraction.

-c) The fact that particles can make glancing collisions with the edge of a slit.

-d) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert between pairs of particles.

-e) Forces that the De Broglie [[w:pilot wave|pilot wave]] exert on individual particles.

{A dead "fly" of mass <math>m</math> 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 <math>\Delta x</math> in the center of the flyswatter will inform you of whether a collision took place. The uncertainty in the fly's position is <math>\Delta x</math> if the fly passed through the hole. The fly's (non-relativistic) speed is now unknown but estimated to be zero with an [[w:uncertainty principle|uncertainty]] that can be calculated from: }

+a) <math> m\Delta v \cdot \Delta x \geq \frac{\hbar}{2}</math>

-b) <math> m\Delta v \cdot \Delta x \leq \frac{\hbar}{2}</math>

-c) <math> \Delta v \cdot \Delta x \geq \frac{m\hbar}{2}</math>

-d) <math> \Delta v \cdot \Delta x \leq \frac{m\hbar}{2}</math>

{Observe the second (''wave'') segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' and note the rapid divergence of the wave at each of the two slits (better seen '''[[:File:Doubleslit3Dspectrum.gif|here]]'''). This occurs because significant [[w:Diffraction#Single-slit\_diffraction|single slit diffraction]] occurs for a slit that is sufficiently wide.}

-a) true

+b) false

{The (''wave'') second segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' is based on the fact that the two waves emanating from the two slits can [[w:Interference\_(wave\_propagation)|interfere]] with each other.}

+a) true

-b) false

{The first (''particle'') segment in ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]'' does not depict a diffraction pattern when particles impinge upon two slits because [[w:Classical\_physics|classical (Newtonian)]] physics fails to predict such diffraction.}

+a) true

-b) false

{An ''observer is present'' is the fourth segment of ''[[:File:Wave-particle duality.ogv|Wave-particle duality.ogv]]''. This observer disrupts the diffraction pattern because:}

-a) If '''[[w:Heisenberg's microscope|Heisenberg's 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.

+b) While all of these arguments have been used, the validity of some are '''"[http://arxiv.org/pdf/1208.0034.pdf uncertain]"'''(pun intended).

-c) By the [[w:uncertainty principle|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 [[w:Copenhagen interpretation|Copenhagen interpretation]], knowing that the particle is in one slit destroys the wavefunction at the other slit.

</quiz>