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| **Topic** | Quantum physics research |
| **Subtopic** | DeBoglie wavelength |
| **Concept Name** | The debroglie wavelength and its equation |
| **Description** | De Broglie postulated that in analogy to light, matter could also have particle and wave characteristics. |
| **Formula** | * + Where E represents relative energy equation by Albert Einstein which implies that the energy of a body is its mass multiplied by the speed of light   + De Broglie hypothesized that this energy was also equal to KE standing for kinetic energy and m0c2 being the resting mass energy   + standing for electon momentum   + standing for wavelength   + standing for energy   + standing for Planck’s constant     - Planck’s constant relates to the energy in one quantum also known as photon of electromagnetic radiation to the frequency of that radiation   + standing for frequency |
| **Drawing/Animation** | http://wikipremed.com/01physicscards600/472a.gif |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| --- | --- |
| **Topic** | Quantum physics research |
| **Subtopic** | DeBroglie wavelength |
| **Concept Name** | Quantizized angular momentum and the bohr atom |
| **Description** | De Broglie’s matter wave provided an explanation of the quantization of angular momentum in the Bohr atom. Waves travelling in opposite directions in a confined space can set up a standing wave due to constructive interference. A standing wave in a circle is formed when an integer number of wavelengths fits around the circumference: |
| **Formula** | * + standing for wavelength   + standing for Planck’s constant   + m standing for mass   + v standing for velocity   + r standing for radius   + n standing for orbit   + standing for wavelength   + L is only conserved |
| **Drawing/Animation** | https://myweb.rollins.edu/jsiry/Bohr_atom_mode.svg.png |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| **Topic** | Quantum physics research |
| **Subtopic** | DeBoglie wavelength |
| **Concept Name** | Davisson-Germer Experiment |
| **Description** | Davisson and Germer showed that electrons do behave like matter waves and can be diffracted. Electrons are reflected from the surface of a nickel target. The surface layer of atoms in nickel acts as a diffraction grating. |
| **Formula** |  |
| **Drawing/Animation** | http://dev.physicslab.org/img/7230f851-fb87-46d6-ae06-41a587f774c2.gif https://i.gyazo.com/ca7ed10c220e182b532da6f8c4fa3404.png |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| **Topic** | Quantum physics research |
| **Subtopic** | Matter Waves |
| **Concept Name** | Matter waves |
| **Description** | * Electron diffraction was demonstrated by Davisson and Germer and G. P. Thomson (son of J. J. Thomson). * Subsequently, diffraction for other matter waves such as atoms, neutrons and even molecules has been demonstrated. * Atom interferometers can be constructed using standing waves of light as atomic mirrors and beam splitters * All matter can have wavelike properties. * The electron microscope is based on the wave properties of electrons.] |
| **Formula** | http://www.grandinetti.org/resources/Teaching/Chem121/Lectures/QuantumTheoryofMatter/DeBroglieCalc.gif |
| **Drawing/Animation** | http://www.mysearch.org.uk/website1/images/pictures/526.1.jpg https://i.gyazo.com/d2f673442ee78d1b3d0b162b737069a0.png |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| **Topic** | Quantum physics research |
| **Subtopic** | Heisenberg uncertainty principle |
| **Concept Name** | Minimum uncertainty |
| **Description** | * Our knowledge of conjugate quantities is inherently uncertain. * No matter how good our measuring instruments are we cannot simultaneously know x and p or E and t with complete precision. |
| **Formula** | * Heisenberg uncertainty principle * For Gaussian functions |
| **Drawing/Animation** | http://www.electrical4u.com/addpost/images/precisely%20determined%20momentum-2.jpg |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| **Topic** | Quantum physics research |
| **Subtopic** | Schrödinger's Equation |
| **Concept Name** | Time-Dependent Equation |
| **Description** | * The wave function   + The state of a physical system is represented by a wave function which contains all the information that can be known about the system.   + The wave function is in general complex (it has real and imaginary parts) * The wave function of a particle undergoing a force F(x) is the solution to the Schrödinger equation: |
| **Formula** | https://i.gyazo.com/5f7b78b0a6528bbc0c5baa6d0aaf6b80.png  U(x) is the potential energy associated with the force: |
| **Drawing/Animation** |  |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| **Topic** | Quantum physics research |
| **Subtopic** | Schrödinger's Equation |
| **Concept Name** | Separation of variables |
| **Description** | Since U(x)does not depend on time, solutions can be written in separable form as a part that is only position dependent and a part that is only time dependent: |
| **Formula** | * Ψ(x,t)=ϕ(x)χ(t)   Left hand side (LHS) is a function of t alone. Right hand side (RHS) is a function of xx alone.  LHS=RHS only if LHS = E and RHS = EE (EE is a constant).  Solutions for the time-dependent equation:  Check: |
| **Drawing/Animation** |  |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| --- | --- |
| **Topic** | Quantum physics research |
| **Subtopic** | Schrödinger's Equation |
| **Concept Name** | Time-independant Equation |
| **Description** | This equation is not always easy to solve analytically, but can be solved numerically on a computer. However we can analytically solve some special cases…. |
| **Formula** | Physically acceptable solutions ϕ(x)ϕ(x) (stationary states) must satisfy certain conditions:   1. ϕ(x) must be normalized 2. ϕ(x) must be continuous 3. ϕ(x) must be single valued 4. U(x)=0 in regions where it is physically impossible to find the system 5. ϕ(x)=>0ϕ(x)\ri0 as x=>±∞ |
| **Drawing/Animation** |  |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| **Topic** | Quantum physics research |
| **Subtopic** | The Quantum Mechanic Wave Function |
| **Concept Name** | The Quantum Mechanic Wave Function |
| **Description** | * In quantum mechanics, the state of a physical system is represented by a wave function which contains all the information that can be known about the system. * The wave function is in general complex (it has real and imaginary parts). |
| **Formula** | In configuration (coordinate) space the wave function of a particle is a function of the position of the particle at a given time:  Ψ(x,y,z,t)Ψ(x,y,z,t)  For NN particles, this can be generalized to  Ψ(x1,x2,...xN,y1,y2,...yN,z1,z2,...zN,t) |
| **Drawing/Animation** |  |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| --- | --- |
| **Topic** | Quantum physics research |
| **Subtopic** | The Quantum Mechanic Wave Function |
| **Concept Name** | Normalization |
| **Description** | * The wave functions Ψ and cΨ represent the same state, where cc is a complex number. * We can always multiply the wave function by an arbitrary complex number without changing it. * Multiple of a Ψ function by a complex number does not change any observable quantity that can be measured about the particle. |
| **Formula** | Consider the normalization integral  If I is a finite number, then the wave function is square integrable. If we multiply the wave function by a constant.  then the wave function is said to be normalized (to unity): |
| **Drawing/Animation** |  |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| --- | --- |
| **Topic** | Quantum physics research |
| **Subtopic** | The Quantum Mechanic Wave Function |
| **Concept Name** | The Born Interpretation: Probabilities |
| **Description** | P(x,t)P(x,t)  is called the probability density function. It yields the probability of the particle being in the region dxdx around position xx at time tt  Hence the normalization requirement is a statement that the probability of finding the particle somewhere is 1. |
| **Formula** | * The absolute square of the normalized wave function ΨΨ :   The probability of finding a particle in a region a |
| **Drawing/Animation** |  |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |

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| **Topic** | Quantum physics research |
| **Subtopic** | The Quantum Mechanic Wave Function |
| **Concept Name** | Superposition principle |
| **Description** | If the wave functions  Ψ1 and Ψ2  represent two possible states of the system, then any linear combination  Ψ=c1Ψ1+c2Ψ2  also represents a possible state of the system. This is the superposition principle.  This allows for superpositions of a particle wave function in two different locations (Recall double slit experiment).  Note the last two terms from the double slit experiment with electrons. |
| **Formula** |  |
| **Drawing/Animation** |  |
| **Relevant Tags** | Hashtag all relevant topics discussed in this module (e.g. #forces #gravity #acceleration) |