Equations for Quantum physics:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name | Equation | | | Variables | |
| De Broglie Wavelength |  | | | Variables   * : wavelength * : 6.62607004 × 10-34 m2 kg / s * = mv | |
| De Broglie Wavelength and the Bohr Atom |  | | |  | |
| Electron energy |  | | |  | |
| Orbit Radius |  | | |  | |
| Minimum uncertainty: |  | | | **Variables**   * xx:position * kk:wave number * ωω:angular frequency * tt:time * pp:momentum * ℏℏ:h-bar * EE:energy | |
| Time-dependent Schrödinger Equation |  | |  | | |
| Time-independent Schrödinger Equation | http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/imgqua/seq13.gif | | |  | |
| Schrödinger Equation in 3-D | http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/imgqua/s3d1.gif | | |  | |
| Solutions of the Angular Equation | https://i.gyazo.com/eb089b2c2c0ed9ed0ee13fea4f83d04f.png | | |  | |
| The Quantum Mechanic Wave Function | https://i.gyazo.com/b0333e2947c4966bcefc76d1e7c4dc6e.png | | | * 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). | |
| Normalization | https://i.gyazo.com/506940048cd6359070274a50b1a239c6.pnghttps://i.gyazo.com/20601a7dff87555109e620a605db4e52.png | | | * The wave functions ΨΨ and cΨcΨ 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 ΨΨ function by a complex number does not change any observable quantity that can be measured about the particle. | |
| The Born Interpretation: Probabilities | https://i.gyazo.com/240a5f675478d7e2dab92937514a71f7.png | | |  | |
| Superposition Principle |  | | |  | |
| Operators and Observables |  | | |  | |
| Expectation values |  | | |  | |
| Spectroscopy and Atomic Structure |  | | |  | |
| Spectral Lines of Hydrogen | https://i.gyazo.com/8ce340fce338fe6ac02eab03880d7dd6.png | | |  | |
| Bohr Model of the Atom | https://i.gyazo.com/a93824025f63b00f0ef365da0f29b15e.png | | | |  |
| Frank-Hertz Experiment |  | | | In 1914, Franck and Hertz directly measured the energy quantization of atoms via the inelastic scattering of electrons.  Measure current of electron beam (I) vs. accelerating grid voltage (V) inside a glass tube filled with mercury gas.  Results: A series of peaks and dips are seen in the current as a function of accelerating voltage  Explanation:   * As V is increased electron energy increases. * Electrons can reach the collector if they overcome the retarding potential of 1.5V. At this point current starts to increase. * As V is increased further, electrons gain enough energy to excite the mercury atoms to their first excited state and hence lose energy. * These electrons cannot overcome the retarding potential and the current dips. * As V is increased further, the electrons again reach an energy that excites the mercury atoms and hence lose energy again. * This repeated process causes the rise and dips of current. * Each dip corresponds to a transition between quantized energy levels in mercury.   The energy of the electrons at which the dips occur correspond to the first excitation energy of mercury (4.9eV) | |
| Black Body |  | A black body is an object that absorbs all electromagnetic radiation that falls on it. Since it does not reflect any radiation it appears black.  Black bodies are not only perfect absorbers but also perfect emitters of radiation. They emit the maximum amount of energy possible at a given temperature.  In reality no object is a perfect black body.Some examples of approximate black bodies: Graphite (absorbs over 95% of incident radiation), Stars: absorb and emit at all wavelengths | | | |
| Stefan-Boltzman Law | https://i.gyazo.com/4e992dd2ea00a19a88bf9f0803f01adc.png | | |  | |
| Wien’s Displacement Law | https://i.gyazo.com/b011c49385348726bf048c7b64930af5.png | | | The peak wavelength, λmaxλmax, is inversely proportional to temperature, TT. | |
| Rayleigh-Jean’s Law for the Spectral Energy Density |  | | |  | |
| Wien’s Exponential Law for the Spectral Energy Density |  | | |  | |
| Planck's Law for the Spectral Energy Density |  | | |  | |
| Photoelectric Effect |  | | |  | |
| Classical Explanation of Photoelectric Effect |  | | |  | |
| Einstein’s Explanation of Photoelectric Effect |  | | |  | |
| Scattering of X-rays from an Electron |  | | |  | |
| Compton Shift |  | | |  | |
| The Free Particle | https://i.gyazo.com/e91ea2af0270550a7640ccce4fab3952.png | | |  | |
| Particle in a Box (infinite square well potential) |  | | |  | |
| Finite Square Well Potential |  | | |  | |
| The Square Barrier |  | | |  | |
| The Step Barrier | https://i.gyazo.com/26bcc758a4acf080ca50fe6ab41d3f2a.png | | |  | |

* [Wave Nature of Matter](http://hopper.wlu.ca/upod/page.php?id=457)
  + [Wave Nature of Particles](http://hopper.wlu.ca/upod/page.php?id=457#s2741)
  + [De Broglie Wavelength](http://hopper.wlu.ca/upod/page.php?id=457#s2742)
  + [De Broglie Wavelength and the Bohr Atom](http://hopper.wlu.ca/upod/page.php?id=457#s2743)
  + [Davisson-Germer Experiment](http://hopper.wlu.ca/upod/page.php?id=457#s2744)
  + [Matter Waves (but waves matter too)](http://hopper.wlu.ca/upod/page.php?id=457#s2745)
* [Heisenberg Uncertainty Principle](http://hopper.wlu.ca/upod/page.php?id=458)
  + [Minimum uncertainty:](http://hopper.wlu.ca/upod/page.php?id=458#s2689)
* [Schrödinger's Equation](http://hopper.wlu.ca/upod/page.php?id=459)
  + [Time-dependent Schrödinger Equation](http://hopper.wlu.ca/upod/page.php?id=459#s2746)
  + [Time-independent Schrödinger Equation](http://hopper.wlu.ca/upod/page.php?id=459#s2747)
* [Hydrogen Atom](http://hopper.wlu.ca/upod/page.php?id=463)
  + [Schrödinger Equation in 3-D](http://hopper.wlu.ca/upod/page.php?id=463#s2754)
  + [Solutions of the Angular Equation](http://hopper.wlu.ca/upod/page.php?id=463#s2755)
  + [Solutions of the Radial Equation](http://hopper.wlu.ca/upod/page.php?id=463#s2756)
* [The Quantum Mechanic Wave Function](http://hopper.wlu.ca/upod/page.php?id=473)
  + [The Quantum Mechanic Wave Function](http://hopper.wlu.ca/upod/page.php?id=473#s2705)
  + [Normalization](http://hopper.wlu.ca/upod/page.php?id=473#s2706)
  + [The Born Interpretation: Probabilities](http://hopper.wlu.ca/upod/page.php?id=473#s2707)
  + [Superposition Principle](http://hopper.wlu.ca/upod/page.php?id=473#s2708)
* [Operators and Observables](http://hopper.wlu.ca/upod/page.php?id=481)
  + [Operators and Observables](http://hopper.wlu.ca/upod/page.php?id=481#s2724)
  + [Expectation values](http://hopper.wlu.ca/upod/page.php?id=481#s2725)
* [Particle Nature of Light](http://hopper.wlu.ca/upod/page.php?id=482)
  + [Spectroscopy and Atomic Structure](http://hopper.wlu.ca/upod/page.php?id=482#s2866)
  + [Spectral Lines of Hydrogen](http://hopper.wlu.ca/upod/page.php?id=482#s2867)
  + [Bohr Model of the Atom](http://hopper.wlu.ca/upod/page.php?id=482#s2868)
  + [Frank-Hertz Experiment](http://hopper.wlu.ca/upod/page.php?id=482#s2869)
  + [Black Body Radiation](http://hopper.wlu.ca/upod/page.php?id=483)
    - [Black Body](http://hopper.wlu.ca/upod/page.php?id=483#s2667)
    - [Stefan-Boltzman Law](http://hopper.wlu.ca/upod/page.php?id=483#s2668)
    - [Wien’s Displacement Law](http://hopper.wlu.ca/upod/page.php?id=483#s2669)
    - [Rayleigh-Jean’s Law for the Spectral Energy Density](http://hopper.wlu.ca/upod/page.php?id=483#s2670)
    - [Wien’s Exponential Law for the Spectral Energy Density](http://hopper.wlu.ca/upod/page.php?id=483#s2671)
    - [Planck's Law for the Spectral Energy Density](http://hopper.wlu.ca/upod/page.php?id=483#s2672)
  + [Photoelectric Effect](http://hopper.wlu.ca/upod/page.php?id=484)
    - [Photoelectric Effect](http://hopper.wlu.ca/upod/page.php?id=484#s2892)
    - [Classical Explanation of Photoelectric Effect](http://hopper.wlu.ca/upod/page.php?id=484#s2893)
    - [Einstein’s Explanation of Photoelectric Effect](http://hopper.wlu.ca/upod/page.php?id=484#s2894)
  + [Compton Scattering](http://hopper.wlu.ca/upod/page.php?id=485)
    - [Scattering of X-rays from an Electron](http://hopper.wlu.ca/upod/page.php?id=485#s2739)
    - [Compton Shift](http://hopper.wlu.ca/upod/page.php?id=485#s2740)
* [Black Body Radiation](http://hopper.wlu.ca/upod/page.php?id=483)
  + [Black Body](http://hopper.wlu.ca/upod/page.php?id=483#s2667)
  + [Stefan-Boltzman Law](http://hopper.wlu.ca/upod/page.php?id=483#s2668)
  + [Wien’s Displacement Law](http://hopper.wlu.ca/upod/page.php?id=483#s2669)
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  + [Planck's Law for the Spectral Energy Density](http://hopper.wlu.ca/upod/page.php?id=483#s2672)
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