- The DeBroglie wavelength is given by
$$\lambda = \frac{h}{p}$$
- A good estimate of whether wave mechanics are needed for a problem is whether the scale of the problem is the same order of magnitude or so as the DeBroglie wavelength.
- Arguments for a particle model of light:
  - Light can be quantized into photons
  - In the photoelectric effect, intensity alone is not enough to cause the effect. Individual photons must have enough energy
- Arguments for a wave model of light:
  - Light interferes with itself in the double slit experiment
- The ultraviolet catastrophe occurs when light is not quantized. It predicts that the intensity of radiation at a particular frequency increases with the square of frequency, so a black body would give off infinite amounts of energy.
- Wien's displacement law predicts that the most intense wavelength given off by a black body is
$$\lambda_{\text{max}} = \frac{b}{T}$$
where b is a constant.
- Stefan's law (also known as the Stefan-Boltzmann law) states that the power radiated by a perfect blackbody at temperature T is
$$R_T = \sigma A T^4,$$
where $\sigma = \frac{2\pi^5 k^4}{15c^2h^3}$ and A is the area of the object.
- The photoelectric effect experiment involves shining a light at a target surface, and measuring the maximum energy of the freed electrons by measuring the potential required to stop all of them. Under the wave model, any energy of light would be enough to free electrons, and increasing the intensity of the light increases the stopping potential required. In reality (and under the particle model), there is a minimum energy required to free electrons, and only increasing photon energy can increase the stopping potential.
- The photoelectric effect equation is
$$V_0 = \frac{h\nu}{e} - \frac{w_0}{e}$$
where h is Planck's constant, e is the charge of the electron, w_0 is the work function of the target, and ν is the frequency of incoming photons.

- The Compton Scattering equation is

$$\lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\theta)$$

where λ is the initial wavelength, λ' is the wavelength after scattering, and θ is the angle the scattered electron goes off at.

- The Heisenberg uncertainty principle states that

$$\Delta x \Delta p \geq \frac{\hbar}{2}$$

where Δx is the uncertainty in position, Δp is the uncertainty in momentum, and $\hbar$ is the reduced Planck constant.

- The origin of the uncertainty principle comes from the wave interpretation of particles. If a particle is seen as a wave packet, either it is spread out, which gives a good estimate of the momentum but a poor estimate of position, or the wave packet is very short, giving a good estimate of position but not much information about momentum.

- For a one-dimensional, time-independent wavefunction, the Schrödinger equation is

$$-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + U(x)\psi(x) = E\psi(x)$$

with the addition that

$$\int_{-\infty}^{\infty} |\psi(x)|^2 dx = 1$$

- How to normalize a wavefunction $\psi(x)$: Integrate $a = \int_{-\infty}^{\infty} |\psi|^2 dx$. Then the normalized verion of ψ is $1/\sqrt{a}\psi$

- To prove that a wavefunction is an allowed wavefunction of a given potential, see if it is a solution to the relevant Schrödinger equation, satisfying the boundary conditions and normalization condition.

- A 1D wavefunction has units of $1/\sqrt{d}$, where d is distance.

- The energy levels of an infinite potential energy well are

$$E = \frac{h^2}{8mL^2}(n_x^2 + n_y^2 + \dots)$$

For finite potential wells, a numerical solution must be found.

- The probability that a particle will be found in the range $[a, b]$ is

$$\int_a^b |\psi|^2 dx$$