2.E: Foundations of Quantum Mechanics (Exercises)

Q2.1

Construct graphs from the following data to illustrate the key features of the photoelectric effect. Determine the work function for Ni and a value for Planck's constant from the data.

Photoelectric Effect for a Nickel Metal Film

wavelength(nm)	relative light intensity	relative electron current	electron kinetic energy (eV)
400	1	0	0.00
350	1	0	0.00
300	1	0	0.00
250	1	0	0.00
200	1	1	0.98
150	1	1	3.05
100	1	1	7.19
50	1	1	19.60
150	1	1	3.05
150	2	2	3.05
150	3	3	3.05
150	4	4	3.05
150	5	5	3.05
150	6	6	3.05
150	7	7	3.05
150	8	8	3.05
150	9	9	3.05

Q2.2

Suppose you need to take an absorption spectrum of a naphthalene sample in the near-UV region, around 320 nm. How much intensity is gained in this region by using an expensive tungsten filament lamp ($75) with a color temperature of 3400 K compared to an inexpensive lamp ($7.50) with a color temperature of 2800 K? Which lamp would you purchase and why? List all of the assumptions you made in formulating your answer.

Q2.3

Calculate the de Broglie wavelength for an electron in the first Bohr orbit of the hydrogen atom and compare this wavelength with the circumference of the orbit. What insight do you gain from this comparison?

Q2.4

Neutrons as well as electrons and x-rays are used to obtain information about molecular structure through diffraction patterns. What must the velocity of a neutron be for its de Broglie wavelength to be about five times smaller than a bond length? Do you consider this velocity to be large or small? Two typical bond lengths are: C-C = 1.54Å and C-H 1.08 Å.

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