**Chem 6854: Physical Chemistry**

**Homework Assignment #1**

**Quantum Beginnings and `Review’ of Complex #**

(40 points/ 3 points per problem except where noted)

Show all work !

Due Wednesday 3 Feb

* 1. ) DeBroglie proposed the notion of a `matter wave’ wherein a mass m’s wavelength λ obeys p = mv= h/λ. Qualitatively explain the source and reasoning underlying this assertion and how you interpret the meaning of the `wavelength’ of matter, λ, conceptually.

1.2) DeBroglie’s matter wavelength, λ , was the critical `big idea’ underlying Bohr’s derivation of the H

atom energy and electronic radius. Central to Bohr’s thinking was that if r is the stable

radius of the electron’s orbit in H, then the electron’s radius must obey the equation :

2πr = nλ (see equation 1.15, pg 19)

where λ is specifically the `matter wave’ for the electron and n is a positive integer (1,2,3…)

1. Why can’t n be non-integer ?
2. Why can’t n be 0 ?

1.3a) Derive Bohr’s prediction for the electron velocity v in an H atom as function of n and physical

constants K, e, h and m given: (4 pts)

Fcentripetal = mv2/r= Fcoulombic = Ke2/r2

p=mv= h/λ

2πr= nλ

E= 1/2mv2 – Ke2/r

1.3b) Given: K=9\*109 e= 1.602\*10-19 coulombs ħ=1.055\*10\_34 Joule sec m = 9.1\*10-31 kg

Compute v of an H atom’s electron in the ground (n=1) state using your derived form in 1.3a (units should come out in m/sec).

1.4. Problem 1-12 of text. (Black Body calculation)

1.5. Problem 1-18 of text. (Photoelectric effect calculation)

1.6. Problem 1-21 of text. (H atom line spectrum calculation)

1.7. Problem 1-22 of text. (H atom line spectrum calculation)

1.8 Problem 1.25a of text. (De Broglie wavelength problem) Note that:

E=100 eV = 1.6\*10-17J and that p2/2m = E

1.9. Problem 1-27 of text. (DeBroglie wavelength🡪 potential problem) Note that:

Ve= p2/2m

e(proton) = 1.602\*10-19 C

m(proton) = 1.66\*10-24 g = 1.66\*10-27 kg

=>V in volt units

1.10 Problem 1.37 of text (equivalent Heisenberg uncertainty relationships)

1.11 Problem 1.38 of text (Heisenberg time uncertainty)

1.12 Imaginary number expressions: (see page 35 MathChapter A) (2 pt per answer)

Problems A-1 b, A-2b, A-3b

**Extra credit: Problem 1-5 of text. You can use EXCEL in `SOLVE’ mode to find x such that: e-x+x/5-1 = 0 (10 pts)**