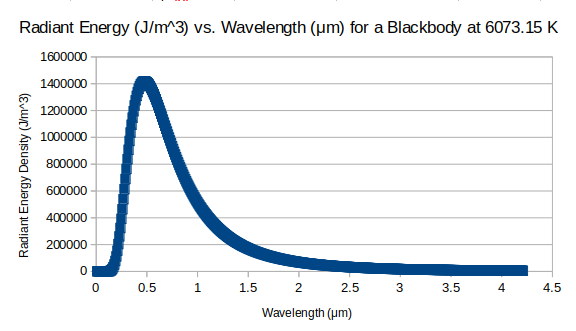
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| CHEM 3322: Physical Chemistry II | Jonathan Riezman |
| Assignment 1 Part B | 02/13/2021 |

1a)

b) 99.033%

2a) so xy is an eigenfunction of this operator with eigenvalue 2.

b) so is an eigenfunction of this operator with eigenvalue 49.

c) so x2 is an eigenfunction of this operator with eigenvalue 1/4 .

3) Given the wave function . To normalize this wave function we need N such that , that is . Because the variables are separable we can do each of the three integrals by itself then find the product of those results. First , then we have and finally . Finding the product of these terms gives us .

4) In complex function space the condition for orthogonality for two functions ψ and ɸ is . For the given functions we calculate , but because the entire integral is zero and therefore the functions are orthogonal in complex function space.

5) r = 5.1961, θ = 45.000° = π/4 radians, ɸ = 54.736° = 0.95532 radians

6a) The commutator of two operators is defined as for an arbitrary function, f(x). It is equal to 0 if the operators commute. For position and linear momentum operators we have (primes are used instead of deltas for brevity since this is 1D) .

b) Since the commutator is not zero the operators do not commute for arbitrary functions. Trivially, these operators commute for the zero function, f(x)=0.

7a) Note that because the ɸn are orthonormal . Note also that . Given our function in terms of the orthonormal ɸn we have

. Therefore Ψ is normalized.

b) E1, 2E1, and 4E1

c) 3/8, 3/16, and 7/16 with respect to the order of the previous answer.

d)

8a) The probability that a particle with wave function Ψ will be found in a given interval (0, a/4) is . For our 1D particle in an infinite well . As a function of the quantum number, n.

b) As n approaches infinity and so probability approaches ¼ as expected in classical physics, where the particle has an equal chance of being at any point in the well.

9a) 9.6394678 x 10-19 J at n=1

3.8557871 x 10-18 J at n=2

2.4098670 x 10-17 J at n=5

b) 68.6914081 nm

10a) 5.9885 x 10-35for n=1

1.7614 x 10-34 for n=2

b) 1.7614 x 10-34 > 5.9885 x 10-35> 5.27286 x 10-35 = h/4π

c) 4.5189 x 10-11 for n=1

6.6459 x 10-11 for n=2