Assignment I

Marks: 5
Due: 26-8-2023

(I) If the maximum intensity of a radiation source is at the wavelength of $\lambda_{source} \sim 5000$ Å , find its temperature in ^{O}K and express the same eV. If the wavelength of the maximum intensity of an X -ray star is 5 Å, find its surface temperature.

(II) Using the relation of the Stephen Boltzmann relation find the total power per unit surface are emitted by a black body surface, whose temperature is 6500 K.

(III) (a)What is de Broglie's wavelength of a nonrelativistic proton with a kinetic energy of 1.0 MeV? (b) Find the velocity of electron having energy 1.0 MeV?

(IV) The uncertainty in the momentum Δp of a ball travelling at 20 m/s is 1×10^{-6} of its momentum. Calculate the uncertainty in position Δx? Mass of the ball is given as 0.5 kg.

(V) If the scattered X-rays are detected at 30° relative to the incident X-rays, determine the Compton shift at this angle of the recoiling electron?

(VI) If the detector measures a wavelength for the scattered x-rays of 0.2412 nm, what is the x-ray scattering angle? [Given X ray wavelength is 0.2400nm].

(VII) Life-time of an excited state of atomic level is estimated to be 1 nano-second (10^{-9} sec) and its corresponding emitted photon having wavelength 589 nm. Estimate the uncertainty in energy (express in eV) of the excited state.

(VIII) Find Δp and Δx for ground state and first excited state of SHO.

(IX) Diagonalize the following metrics:

$$\begin{pmatrix} 0 & 1 & 1 \\ -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

(X) For the given gate, find its outputs if the input states (|xy>) are |00>, |01>, |10> and |11>
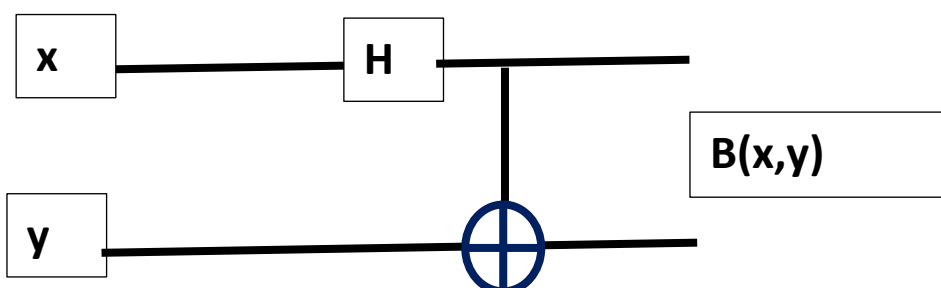
[2]

Using $|B(1,1)>$ from the above problem, using the below given expression

$|B(1,1) > < B(1,1)|$ = (1/2) [A |00><001| + C |01><01| + D |10><10| + E |11> <11|]

(i)   Find A, C, D and E   (where A, C , D and E are constants)
(ii) $Find\ the\ density\ matrix\ for\ B(1,1)$
(iii)   In the above express, If A=C=E=D=1,   find the matrix   [4]

(XI) $Using\ the\ relation\ R_x(\theta) = exp-(i\theta\hat{\sigma}x)$, where $\hat{\sigma}x\ is\ Pauli\ x-$
$matrix, (a)find\ the\ R_x(\theta)$. {Hint: Treat Pauli matrix as operator, write down all
the necessary steps} (b) For a given input |0>, find the output state when $\theta =$
$0, \frac{\pi}{2}, \pi$ using
$R_x(\theta)|0 >$ [2+1]

(XII)   A density operator for some system is given by $\rho = \begin{pmatrix} 2/3 & 1/6 - i/3 \\ 1/6 + i/3 & 1/3 \end{pmatrix}$.

Find out the Bloch vector for this state. Is it pure or mixed? A measurement of spin is made in
the z-direction. What is the probability that the measurement result is spin-down? What is the
probability that the measurement is spin-up?