Engineering Physics
06PHY12
Assignment 1

Answer the following questions

1. Explain the energy distribution in the spectrum of a blackbody. Give an account of the attempts made through various laws to explain the spectrum. [8]
2. Give a brief account of blackbody radiation and Planck's radiation law leading to quantization of energy. [4]
3. What is *ultraviolet catastrophe*? [4]
4. What is Planck's radiation law? Show how Wein's law and Rayleigh-Jean's law can be derived from it. [6]
5. Describe photoelectric effect. [5]
6. Explain Compton effect and give its physical significance. [5]
7. Explain the duality of matter-waves from the inferences drawn from photoelectric effect and Davisson-Germer experiment. [5]
8. Verify de Broglie hypothesis of matter-waves by Davission and Germer's experiment. [10]
9. Explain the characteristics of matter-waves. [5]
10. What are matter-waves? Show that the electron accelerated by a potential difference V volts is $\lambda = 1.226/\sqrt{V}\,nm$ for non-relativistic case. [6]
11. Explain phase velocity, group velocity and particle velocity and write down the relation between them. [6]
12. Define group velocity and obtain an expression for the same. [5]
13. Define phase velocity and group velocity. Derive expressions for phase velocity and group velocity on the basis of superposition of waves. [10]
14. Show that particle velocity and group velocity are identical. [5]
15. Derive the expression for de Broglie wavelength using the concept of group velocity. [5]

Solve the following problems

1. Calculate the de Broglie wavelength of a $0.3\,kg$ cricket ball of speed of $120\,km/hr$. [4]
2. A particle of mass $0.65\,MeV/c^2$ has free energy $120\,eV$, c is the velocity of light. Find its de Broglie wavelength. [5]
3. Compare the energy of a photon with that of a neutron when both are associated with wavelength of $1\,\mathring{A}$, given that the mass of neutron is $1.678 \times 10^{-27}\,kg$. [5]
4. Calculate the wavelength associated with electrons whose speed is 0.01 of the speed of light. [7]
5. Calculate the wavelength associated with an electron of energy $1.5\,eV$. [5]

6. Estimate the potential difference through which an electron is needed to be accelerated so that its de Broglie wavelength becomes equal to $10\mathring{A}$. [5]

7. In Davission-Germer experiment, the electron beam is accelerated to a potential $25\,kV$. Calculate the de Broglie wavelength associated with electrons. Given $m = 9.1\times10^{-31}\,kg$; $h = 6.62\times10^{-34}\,Js$ and $e = 1.6\times10^{-19}\,C$. [5]

8. A particle of mass $0.65\,MeV/c^2$ has a kinetic energy $80\,eV$. Calculate the de Broglie wavelength, group velocity and phase velocity of the de Broglie wave. [5]

9. An electron beam has a de Broglie wavelength of $2\times10^{-12}\,m$. Find the kinetic energy, phase and group velocities of de Broglie waves. [5]

10. If an electron has a de Broglie wavelength of $2\,nm$, find its kinetic energy and group velocity, given that it has a rest mass energy of $511\,keV$. [5]

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