JOINT INSTITUTE
交大密西根学院

MODERN PHYSICS (Summer 2020)

Review Questions
(week of 25 May 2020)

1. A photon has energy ε. What is its momentum?
2. Give an example illustrating the equivalence principle in the general theory of relativity.
3. Can the Bohr model be applied to describe a He atom? How about a He^+ ion?
4. What kind of experiment disproved the Thomson's model of the atom? The Rutherford's model that correctly reproduced the experimental data assumed that ....
5. According to Bohr's model of the hydrogen atom, the electron moves in a circular orbit such that the magnitude of its angular momentum is ....
6. (*True or false?*) According to Bohr's model of the hydrogen atom, the electron moving in a circular orbit with $L_z = n\hbar$ (where $n = 1, 2, \ldots$) emits electromagnetic radiation.
7. State the postulates of Bohr's model of the hydrogen atom.
8. According to Bohr's model, when is the hydrogen atom able to emit or absorb electromagnetic radiation? What is its frequency equal to?
9. The energy levels of the hydrogen atom are $E_n = \ldots\ldots\ldots E_0$, where $E_0 = 13.6$ eV and $n =$ ....
10. In quantum mechanics, the state of a system with the lowest energy is called the ....state.
11. The radius of the first Bohr orbit in the hydrogen atom is of the order of (a) 10^{-11} m, (b) 10^{-18} m, (c) 10^{-6} m.
12. State the correspondence principle.
13. What was the idea of the Frank–Hertz experiment and what did it confirm?
14. In the original Frank–Hertz experiment with the gas tube filled with mercury atoms, dips in the current were observed for the values of the accelerating potential differing by ca. 4.9 V. Does it mean that energy levels in the mercury atom are equally–spaced?
15. In the original Frank–Hertz experiment with the tube filled with mercury atoms, dips in the current were observed for the values of the accelerating potential differing by ca. 4.9 V. How would you interpret the second dip that is observed at ca. 9.8 V?
16. The ideal blackbody is modeled as a cavity that ....absorbs incident radiation.
17. What is the 'UV catastrophe'?
18. For the ideal blackbody model sketch the spectral distribution of the energy of thermal radiation (emitted from unit volume in unit time) in equilibrium. On one graph sketch two curves for temperatures T_1 and T_2, where $T_1 < T_2$. Label both curves with the corresponding temperatures.
19. State the Stefan–Boltzman law and Wien law. Explain all symbols in the formulas. $\frac{P}{A} = \sigma T^4$ $\lambda_m T = \text{const}$
20. The average energy per resonant mode of electromagnetic field in the cavity modeling the ideal black body is ....in the classical approach and ....in Planck's model.

21. Where does quantum mechanics appear in the Planck's model of blackbody radiation?

22. Planck's law $u(\lambda) = \frac{8\pi}{\lambda^5} \frac{hc}{e^{hc/k_B T} - 1}$ gives the amount of energy radiated from a unit volume of the ideal blackbody, with wavelength $(\lambda, \lambda + d\lambda)$.

    How do waves with small wavelengths contribute to this energy? Long wavelengths?

23. Write down the photoelectric effect equation. Explains all symbols.

24. Assuming that the magnitude of the electron's charge is known, how can we use the data from a photoelectric effect measurement to find the value of the Planck's constant?

25. In the model of Compton scattering, light is treated as .... scattered off resting ....

26. What does the Young's double-slit experiment illustrate?

27. Sketch the intensity pattern that appears on the screen in the Young's experiment with electrons when (a) both slits are open and we cannot detect which of the slits the electron has passed through; (b) one slit is open; (c) both slits open, but we are able to detect which of them the electron has passed through.