國　立　清　華　大　學　命　題　紙

95 學年度 電機領域聯合招生 系（所） 組碩士班入學考試

科目 近代物理 科目代碼 9912 共 3 頁第 1 頁 *請在【答案卷卡】內作答

單選題，答對一題五分，答錯一題倒扣 1.25 分

1. Which of the followings is not predicted by the classical electromagnetic theory in photoelectric experiment?(A) There is a time delay.(B) There is no cut-off frequency--any frequency should work.(C) The maximum energy of the electrons is a function of the intensity of the light.(D) The number of electrons is a function of the frequency of the light.(E) None of the above.
2. The deBroglie wavelength of an electron being accelerated through 150 voltage drop is about 1×10^{-10} m. What wavelength would a proton have if it were accelerated through the same voltage?(A) 1.84×10^{-7} m.(B) 4.28×10^{-9} m.(C) 2.33×10^{-12} m.(D) 5.45×10^{-14} m.(E) None of the above.
3. In a photoelectric experiment, a stopping potential of 3.1 Volts is measured when UV light with $\lambda = 0.2$ μm is shined on the metal. Using the same metal, what is the new stopping potential if a violet light with $\lambda = 0.3$ μm is used?(A) 1.0 Volts.(B) 3.0 Volts.(C) 4.1 Volts.(D) 6.2 Volts.(E) None of the above.
4. In a Compton scattering event, a $\lambda = 0.10$ nm γ-ray photon strikes a free electron in a head-on collision and knock it into the forward direction. The rebounding γ-ray photon recoiled directly backwards. What is the kinetic energy of the electron?(A) 294 eV (B) 575 eV (C) 11825 eV (D) 12106 eV (E) None of the above.
5. Which of the following statement is correct?(A) The "Ultraviolet Catastrophe" in classical black body radiation was solved by Planck who proposed the quantization of the energy of the oscillators in blackbody wall.(B) The Wein's displacement law asserts that $\lambda_{max} \propto T$ where λ_{max} is the wavelength of maximum intensity of a blackbody and T is the temperature of the blackbody.(C) The break down of the universality of specific heat of crystalline solid (i.e. Law of Dulong and Petit) at low temperature was solved by Einstein who proposed the quantization of light.(D) The conclusive proof of the particle nature of the X-ray was supplied by Laue's X-ray diffraction experiment by crystal.(E) None of the above.
6. For electrons with a kinetic energy of 10 eV, the corresponding de Broglie wavelength is:(A)2.5×10^{-6} cm (B) 5.3×10^{-7} cm (C) 3.9×10^{-8} cm (D) 2.4×10^{-9}cm (E) 3.1×10^{-10}cm.
7. In a cathode ray tube, the electron velocity is about 10^6m/s. Suppose the uncertainty on the electron velocity is about 0.1%. The uncertainty on the electron position is (A) 2.4×10^{-5} m/s (B) 3.7×10^{-6}m/s (C) 3.5×10^{-7}m/s (D) 5.8×10^{-8}m/s (E) 7.2×10^{-9} m/s

8. The size of the nucleus in an atom is on the order of: (A) 10^{-9} cm (B) 10^{-10}cm (C) 10^{-11}cm (D) 10^{-12}cm (E)10^{-13}cm
9. The mass of $\pi\pm$ meson is about: (A)137 (B) 207 (C)264 (D)273 (E)1836 times of the electron mass.
10. An electron is confined in a one-dimensional potential well. The width of the potential well is L. If the ground state energy of the electron at room temperature is kT, where k is Boltzmann's constant and is equal to 1.38×10^{-23} J/K, the width of the potential well is about: (A)1.84 nm (B)3.82 nm (C) 4.78 nm (D) 6.29 nm (E) 8.43 nm
11. Let Lx, Ly, Lz be the three Cartesian components of angular momentum operator. Which of the following statements is true?
    (A) The commutator [Lx, Ly] is hermitian.(B) Lx, Ly and Lz are commutative. (C)Lx, Ly, and Lz can be simultaneously diagonalized.(D)A quantum state of $L^2 = Lx^2+Ly^2+Lz^2$ is necessarily the eigenstate of Lx, or Ly, or Lz.(E)None of the above is true.
12. Consider a beam of spin 3/2 particles in Stern-Gerlach experiment. How many lines would it split into after they pass the magnet?(A)1 (B) 2 (C) 3 (D) 4 (E) 5.
13. Consider a spin 1/2 particle moving in a hydrogenic potential. Which of the following values cannot be the quantum number of Lz + Sz, the sum of z-components of orbital and spin angular momenta?
    (A)0 (B) 1/2 (C) -1/2 (D) 3/2 (E) -3/2 (in units of $\hbar$).
14. If a spinless particle moves in a cylindrically symmetric potential V(|r|, z), the corresponding Hamiltonian operator $H = -\hbar^2\nabla^2/2m + V$ commutes with
    (A)Lx (B) Ly (C) Lz (D) $L^2 = Lx^2+Ly^2+Lz^2$ (E) none of the above.
    (Note: Lx, Ly, and Lz are the three Cartesian components of angular momentum operator.)
15. Given the following matrix for the angular momentum operator Lx

$$\begin{matrix} 0 & 0 & 0 \\ 0 & 0 & -i \\ 0 & i & 0 \end{matrix}$$

    what are the eigenvalues of Lx?
    (A) -1,0,1 (B) -1/2, 0, 1/2 (C) -2, 0, 2 (D) -3/2, 0, 3/2 (E) none of the above.
16. The Fermi level of a free electron gas of volume V and N electrons at 0°K is proportional to (A) $(h^2/m_e)(N/V)^{2/3}$ (B) $(h/m_e)(N/V)^2$ (C) $(h^2/me)(V/N)^2$ (D) $(h/m_e)(V/N)^{1/2}$ (E) none of the above. h is the Planck constant, m_e is the electron mass.

17. The probability that a conduction electron in a metal has an energy equal to the Fermi energy at the temperature 300°K is (A)0.21 (B)0.99 (C)1 (D) 0.5 (E) none of the above.
18. Electrons are free to move with only a small applied field in a metal, which of the following statements is correct? (A)because metal has small energy gap (B) because metal has a completely filled conduction band (C) because metal has a high value of Fermi energy (D) because there are many unoccupied energy states very close to occupied energy states (E) all of the above statements are corrrect.
19. In order for a laser to function, it is necessary that (A) thermal in-equilibrium is reached (B) a gain medium is placed inside the mirror cavity (C) a population inversion is obtained (D) stimulated emission occures (E) all of the above statements are correct.
20. Which of the following phenomena is not caused by tunneling effect: (A) thermionic emission (B) ammonia inversion (C) α-decay (D) field emission (E)electrical conductivity through thin oxide layer.

Physical Constants

Plank Constant $h = 6.63\times10^{-34}\,\mathrm{J\cdot s}$, Speed of light $c = 3.00\times10^{8}\,\mathrm{m/s}$,

Electron mass $m_e = 9.11\times10^{-31}\,\mathrm{Kg}$, Proton mass $m_p = 1.673\times10^{-27}\,\mathrm{Kg}$,

Electron Charge $e = -1.6\times10^{-19}\,\mathrm{C}$, $1\ \mathrm{eV} = 1.60\times10^{-19}\ \mathrm{J}$,

$\frac{h}{m_e c} = 2.43\times10^{-12}\,\mathrm{m}$, $\frac{m_p}{m_e} = 1836$, Boltzmann's constant = 1.38×10^{-23} J/K