# 國　立　清　華　大　學　命　題　紙

九十三學年度 光電工程 系（所） ＿＿＿＿ 組碩士班入學考試

科目 近代物理 科號 2804 共 4 頁第 1 頁 *請在試卷【答案卡】內作答

每題 5 分，答錯倒扣 1.25 分

1. Which of the following statement is correct? (A) From J. J. Thomson e/m experiments, we found the wave nature of the electron. (B) In a photoelectric experiment, there is some time lag between the start of illumination and the start of the photocurrent. (C) The classical theory of blackbody radiation (i.e. the Rayleigh-Jeans Law) fail at large wavelength due to the light quantization proposed by Planck. (D) The most significant contribution of the Millikan's oil-drop experiment is the determination of the mass of the electron. (E) None of the above.

2. What is the major conclusion from Rutherford's alpha particle scattering experiment? (A) The nucleus contains most of the negative charge in the atom.(B) The number of protons and neutrons in the nucleus of an atom is roughly proportional to the number of electrons in the atom. (C) The nucleus consists of protons and neutrons. (D) Most of the mass of the atom is in a very small volume. (E) None of the above.

3. Compton scattering provides evidence for the (A) speed of the x-ray. (B) Particle nature of x-rays.(C) Wave narure of x-rays. (D) Quantization of radiant electromagnetic energy. (E) None of the above.

4. As the potassium (鉀) is shone with a light of wavelength 450 nm, the photoelectrons with stop voltage of 0.52 (V) are emitted. By changing the wavelength of the incident light to 300 nm, the stop voltage becomes 1.90 (V). What is the workfunction of the potassium? (A) 2.24 (eV). (B) 2.42 (eV). (C) 4.66 (eV). (D) 4.74 (eV). (E) None of the above.

5. What is the temperature we need in order to double the total power emitted by a blackbody radiator with temperature $T_0$? (A). $2T_0$ (B). $\sqrt{2}T_0$ (C). $\sqrt[3]{2}T_0$ (D). $\sqrt[4]{2}T_0$ (E) None of the above.

6. Why can't we observe diffraction effects with the de Broglie wavelengths of macroscopic objects? (A) Since the de Broglie wavelength is inversely proportional to the velocity, thus we would not have large enough velocity to do the experiment. (B) Since the de Broglie wavelengths for macroscopic objects will be too large

compared with the dimensions of everyday objects, thus we can not produce diffraction effects. (C) Since the velocity should be low enough to give a large enough de Broglie wavelength, thus we would not have time to do the experiment. (D) Since the de Broglie wavelength is directly proportional to the mass, thus we would not have large enough mass to do the experiment. (E) None of the above.

7. Two beams of particles with mass $M_1$ and $M_2$ respectively are moving with the same velocity $v$ and passing an aperture of diameter $D$. The spread angle $\theta_1$ and $\theta_2$ for the two beams after passing the aperture are measured. Which of the following answers are correct? (A)$\theta_1/\theta_2 = 1$, (B) $\theta_1/\theta_2 = M_1/M_2$, (C) $\theta_1/\theta_2 = (M_1/M_2)^2$, (D) $\theta_1/\theta_2=M_2/M_1$, (E) none of the above.

8. An electron at rest is accelerated by a uniform electric field $E_x$ over a distance $L$. After the accelerator, the instantaneous position $x$ of the electron is to be measured by some means. If the field can be determined to an accuracy $\Delta E_x$, the minimum attainable uncertainty $\Delta x$ would be proportional to: (A) $E_x/\Delta E_x$, (B) $\Delta E_x/E_x$, (C) $(E_x)^{1/2}/\Delta E_x$, (D) $(E_x)^{1/2}\Delta E_x$, (E) none of the above

9. Consider the diffraction of particle in a single crystal, the corresponding de Broglie wavelength $\lambda$ of the particle with kinetic energy $E$ would be proportional to: (A) $E^{-1}$, (B) $E^{-1/2}$, (C)$E^{1/2}$, (D) $E$, (E) none of the above.

10. The wavefunction of a particle in free space satisfies the Schrodinger equation

$$-\frac{\hbar^2}{2m}\frac{\partial^2\Psi(x,t)}{\partial x^2} = i\hbar\frac{\partial\Psi(x,t)}{\partial t}$$

Its solution is $\Psi(x,t) = A\exp[i(px - Et)/\hbar]$. The quantity $p$ would be proportional to: (A) $E^{1/2}$, (B) $E$, (C) $E^{-1/2}$, (D) $E^{-1}$, (E) none of the above.

11. The space part wavefunction of a particle moving in free space can be described by plane wave $\Phi(x) = A\exp(ikx)$. $\Delta x$ is the uncertainty of position and $\Delta p$ is the uncertainty of momentum, ($\Delta x$, $\Delta p$ ) would be proportional to: (A) ( 0, $\infty$) (B) ( $x^{1/2}$, $k^{1/2}$ ) (C) ( $x$, $k$ ) (D) ($\infty$, 0 ) (E) none of the above.

12. For particle in a box, i.e. zero potential energy in the box and infinite potential outside the box, the effect on energy level difference by increasing particle mass would be (A) equivalent to increasing the value of Planck constant (B) equivalent to dividing the quantum number by a factor of 2 (C) equivalent to decreasing the box size (D) equivalent to increasing the zero point energy (E) none of the above.

13. For a charged particle in a quantum harmonic oscillator potential with nature frequency f, when the charged particle transit from a state with higher quantum number $n_1$ to a state with lower quantum number $n_2$, (A) the frequency of the emitted photon is $(n_1-n_2+1/2)f$ (B) there is definitely no photon emission (C) the uncertainty in particle position increased after the transition (D) the uncertainty in particle position does not change after the transition (E) none of the above.

14. A parallel plate capacitor is charged to a potential difference of 10 kV. The plate separation is 0.010 mm and the plate area is 1.0 $cm^2$. Assuming the number of electron impinging on the plate surface is about $1.0 \times 10^{30}$ per second per square centimeter. The transmission coefficient of the tunneling effect is $1.30 \times 10^{-24}$. The electron charge is $1.60 \times 10^{-19}$ Coulomb. The leakage current due to tunneling that passes across the capacitor is estimated to be (A) 1.30 mA (B) 1.60 $\mu$ A (C) 1.23 nA (D) 0.21 pA (E) none of the above.

15. The quantum state of hydrogen atom is specified by a set of quantum number ( n, $\ell$, $m_\ell$,$m_s$ ). Which one of the following states is spherical symmetrical (A) (3, 2, 1, 1/2) (B) ( 3, 2, 0, -1/2) (C) ( 3, 1, 0, 1/2) (D) ( 3, 0, 0, -1/2) (E) none of the above.

16. The eigenfunctions of Hamiltonian operator H are also eigenfunctions of an operator Q, which of the following items is not true (A) the uncertainty of Q is zero (B) the pair of measurement H and Q obeys the Heisenberg's uncertainty principle (C) H and Q are commute (D) the measurement of HQ and QH yield the same result (E) the eigenvalues of H and Q are not the same.

17. In the Stern-Gerlach type of experiment with ground state hydrogen atom, the atomic beam will (A) split into two lines due to spin-orbit interaction (B) not split because the atoms are in the ground state (C) split into two lines due to the existence of electron spin (D) not split because the z-component of orbital angular momentum is zero (E) none of the above.

18. Which one is not the basic idea of Bohr's atom model: (A) the angular momentum is quantized (B) the electron moves in circular orbits about the nuclear (C) radiation is emitted by the atom when the electron changes its state from high energy orbit to low energy orbit (D) the electron is subjected to the Coulomb potential (E) the electron spin has half integer quantum number.

19. Consider an electron in hydrogen atom, the electron is in the $\ell = 3$ state. Assuming there is no spin. Space quantization restricts the allowed angle $\theta$ between the total angular momentum and the z axis to be (A) $\cos\theta = \mp 0.707$ (B) $\cos\theta = \mp 0.500$ (C) $\cos\theta = \mp 0.866$ (D) $\cos\theta = \mp 0.393$ (E) none of the above.

20. Which one of the following item will not cause radiation emitting (A) electron transit from conduction band to valence band (B) a cold black body (C) electron transit from high energy level to low energy level by spontaneous process (D) electron transit from high energy level to low energy level by stimulated process (E) none of the above.