全部都是單選題，每題五分，答錯每題倒扣 1.25 分

1. The quantization of energy proposed by Plank, which gives the correct mathematical law for the blackbody spectrum, open a new era of physics. Which of the following statements is not used in Plank's derivation of blackbody radiation? (A) The atoms in the wall are regarded as small harmonic oscillators with charges. (B) The energies of the harmonic oscillator are quantized. (C) The radiation of the oscillator fills the cavity and acts back on the oscillators in the wall. (D) The energies of the radiations are quantized. (E) None of the above.
2. The X-ray can be produced by bombarding a metal target with high-speed electron. A mechanism call "Bremsstrahlung" is used to explain the production of X-ray. Which part of the X-ray spectrum can be explained by "Bremsstrahlung". (A) The minimum cut-off wavelength. (B) The sharp spike-like spectrum. (C) The smooth continuous spectrum. (D) The maximum cut-off wavelength. (E) None of the above.
3. In an electron microscope electrons are accelerated through an electric potential difference. If you want to alter the electron microscope so that the de Broglie wavelength of the electrons is one-half what it was, you will need to multiply the potential difference by a factor of (A) 4. (B) 2 (C) 1/2 (D) 1/4 (E) None of the above.
4. Which of the following experiments confirmed the de Broglie hypothesis? (A) Geiger-Marsden's experiment on α particle scattering by gold (B) Davisson-Germer experiment on electron scattering by nickel (C) Compton's experiment on X-ray scattering by graphite (D) J. J. Thomson's experiment on deflection of cathode ray by electric and magnetic field (E) None of the above.
5. In the Compton's experiment on X-ray scattering by graphite with $\lambda_0 = 0.071$ nm, the wavelength shift $\Delta\lambda$ observed at an angle of 90° to the incident beam is 0.00243 nm. What is the wavelength shift $\Delta\lambda$ observed at an angle of 45° to the incident beam? (A) 0.00071 nm (B) 0.00122 nm (C) 0.00172 nm (D) 0.00243 nm (E) None of the above.
6. Which of the following statement is correct for photoelectric experiment? (A) The maximum kinetic energy of photoelectron is proportional to the incident light intensity. (B) There is some time lag between the start of illumination and the start of the photocurrent. (C) The stopping potential is proportional to the incident light intensity. (D) Above cut-off frequency, the photocurrent is proportional to the incident light intensity. (E) None of the above.
7. Bohr used the correspondence principle to arrive the condition for orbital stability, the electron therefore (A) behaves classically in the stable orbit (B) has stable energy that is proportional to the square of the quantum number (C) possess

continuous angular momentum (D) for very large orbit, the electron behaves approximately to a classical circular antenna (E) none of the above.

Harmonic oscillation (8-11)

A particle moves in a harmonic-oscillation potential, $\frac{1}{2}m\omega^2x^2$, the wave functions for the ground state and 1st excited state are

$$\varphi_0 = \left(\frac{m\omega}{\pi\hbar}\right)^{1/4} e^{-m\omega x^2/2\hbar}$$

$$\varphi_1 = \sqrt{2}\left(\frac{m\omega}{\pi\hbar}\right)^{1/4}\left(\frac{m\omega}{\hbar}\right)^{1/2} xe^{-m\omega x^2/2\hbar}$$

8. Find out the probability of finding the particle of 1st excited state in the interval(x,x+dx)

(A) $\left(\frac{m\omega}{\pi\hbar}\right)^{1/2} e^{-m\omega x^2/\hbar}dx$ (B) $2\left(\frac{m\omega}{\pi\hbar}\right)^{1/2} x^2e^{-m^2\omega^2\frac{x^4}{4\hbar^2}}dx$ (C) $2\pi^{\frac{-1}{2}}\left(\frac{m\omega}{\hbar}\right)^{3/2} x^2e^{-m\omega\frac{x^2}{\hbar}}dx$

(D) $2\left(\frac{m\omega}{\pi\hbar}\right)^{3/2} x^2e^{-m^2\omega^2\frac{x^2}{\hbar^2}}dx$ (E) None of the above

9. The maximum probability amplitude in problem(8) is located at

(A) $\sqrt{\frac{2\hbar}{m\omega}}$ (B) $\sqrt{\frac{\hbar}{m\omega}}$ (C) $\frac{\hbar}{m\omega}$ (D) $\frac{2\hbar}{m\omega}$ (E) None of above

10. The average value of x^2 for ground state is given by (A) $\frac{\hbar}{2m\omega}$ (B) $\frac{2\hbar}{m\omega}$

(C) $\frac{\hbar^2}{8m^2\omega^2}$ (D) $\frac{\hbar^2}{4m^2\omega^2}$ (E) None of above

p.s. The following equation may be useful.

$$\int_{-\infty}^{\infty} x^{2p}e^{-cx^2}dx = \frac{1\cdot3\cdot5\cdots(2p-1)}{(2c)^p}\sqrt{\frac{\pi}{c}}$$

11. Find the energy levels of a particle moving in a potential of the following form:

$V(x) = \infty; x < 0$

$V(x) = \frac{1}{2}m\omega^2x^2; x > 0$

(A) $E_n = \hbar\omega(2n+\frac{1}{2})$ (n=0, 1, 2 …) (B) $E_n = \hbar\omega(n+\frac{1}{2})$ (n=0, 1, 2 …)

(C) $E_n = \hbar\omega 2n$ (n=0, 1, 2 …) (D) $E_n = \hbar\omega(2n+\frac{3}{2})$ (n=0, 1, 2 …) (E) None of the above

Tunneling Effect (12-14)

The tunneling current in MOS structure with thin gate oxides affects the device performance. The relevant potential barrier experienced by the electron is shown in Fig.1. At the oxide-smiconductor interface, the height of barrier is ϕ_B. The electron with energy E and mass m can be tunneled through the barrier under a strong electric field F. The potential energy for the height of the sloping left side is $V(x) = \phi_B - eFx$.

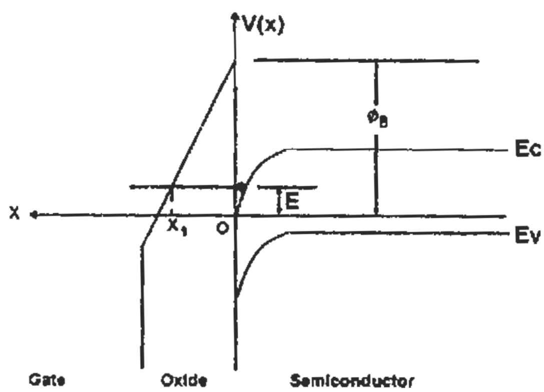

Fig.1

12. From the semi-classical approach, the transmission coefficient is given by

(A) $\exp(\frac{1}{\hbar}\int_0^{x_1}[2m(V(x)-E)]^{3/2}dx)$ (B) $\exp(\frac{-1}{\hbar}\int_0^{x_1}[m(V(x)-E)]^{3/2}dx)$

(C) $\exp(\frac{2}{\hbar}\int_0^{x_1}\sqrt{m(V(x)-E)}dx)$ (D) $\exp(\frac{-2}{\hbar}\int_0^{x_1}\sqrt{2m(V(x)-E)}dx)$

(E) None of the above

13. The turning point x_1 is given by (A) $\phi_B/(eF)$ (B) $(\phi_B - E)/(eF)$
(C) $2\phi_B/(eF)$ (D) $(\phi_B - E)/(2eF)$ (E) None of the above

14. From $E << \phi_B$, the tunneling probability becomes

(A) $e^{-A(\frac{\phi_B}{F})^{3/2}}$; where $A = \frac{4}{3\hbar e}\sqrt{2m}$ (B) $e^{-A(\frac{\phi_B}{F})^{1/2}}$; where $A = \frac{4}{3\hbar e}\sqrt{2m}$

(C) $e^{-A(\phi_B)^{3/2}/F}$; where $A = \frac{4}{3\hbar e}\sqrt{2m}$ (D) $e^{-A(\phi_B)^{1/2}/F}$; where $A = \frac{4}{3\hbar e}\sqrt{2m}$

(E) None of the above

15. Assuming that the life time of a particular state of an excited atom is 1.0×10^{-8}s, when the atom decays from the excited state to the ground state the line width of the emitted light is approximately (A)5×10^{14}HZ (B)8.0×10^{6}HZ (C)all the quantum number of the states need to be known in order to determine the line width (D)the

selection rule need to be known in order to determine the line width (E) None of the above.

16. Which of the following items is not true for stationary state, a stationary state (A) has time independent probability distribution (B) has definite energy value (C) is the solution of the Schrodinger equation for time independent potential(D) has wavefunction with exp(-iωt) time dependence (E) does not exist if the potential is not central-symmetrical.
17. The solutions of Schrodinger equation have to be normalized is the consequence of (A) energy conservation requirement (B) energy quantization (C) the intrinsic wave property of matter (D) Max Born's probability interpretation of wavefunction (E) the uncertainty principle of Heisenberg.
18. In a typical Stern-Gerlach experiment on ground state hydrogen atom, (A) we can conclude that the orbital angular momentum is quantized (B) we can conclude that the magnitude of the orbital angular momentum is conserved (C) the atoms split into three beams (D) the splitting of the atom is independent of the gradient of the applied magnetic field (E) we can conclude that there is other magnetic moment inherit to the electron other than the orbital magnetic moment.
19. Consider a certain kind of atom that has only two energy levels for the electron, the electron at the lower level may absorb a photon and jump up to the higher level, and the higher level electron may emit a photon and jump down to the lower level if it is stimulated by the presence of a photon, and we know that the absorption rate and the stimulated emission rate are equal. The number of atom with electron at higher level is N_2 and the number of atom with the electron at lower level is N_1, in the photon-induced transition process, (A) it is possible that N_2 will be larger than N_1 (B) N_1 will always be larger than N_2 no matter what (C) it is possible that N_2 and N_1 are equal (D) N_1-N_2 will never change (E) none of the above.
20. For a one electron atom, spin-orbit coupling splits all states except s states into doublets, why are s states exception to this rule? (A) s states are spherical symmetrical (B) s states have shell structure (C) the orbital magnetic moment of s states is zero (D) every s state accommodates two electrons (E) none of the above.