近代物理 75%

1. Please calculate the de Broglie wave length of an electron at velocity of 10^6 cm/s **(5%)**

2. For 1D confinement, an electron in box with size of 0.2nm, please find the permitted lowest 2 energies **(10 %)**

3. According to uncertainty principle, please find lowest energy where an electron can have in inside the atom (the size of atom is 5×10^{-11} m^{-3}. **(10 %)**

4. A particle limited to the x axis has the form of $\Psi = ax^2$ between x= -1 to +1. $\Psi = 0$ elsewhere. **(1)** Please find the probability that particle can be found between x=0.3 to 0.4. (5 %) **(2)** Find the expectation value of $\langle x \rangle$ of the particle's position (-1 to 1). **(5 %)**
5. A particle is in a cubic box with infinitely hard walls. The edges length is L. The wave function can be written as

$$\Psi = A \times \sin\left(\frac{n_x \pi x}{L}\right) \sin\left(\frac{n_y \pi y}{L}\right) \sin\left(\frac{n_z \pi z}{L}\right)$$

Please find the normalization constant A **(5%)**

6. According the selection rule in a hydrogen atom system. If an electron is staying at the level of n=4 and l=3. Please write down the possible paths of this electron to relax it energy to n=1 and l=0 according the selection rule. **(10 %)**

7. In the following descriptions, please identify which ones can fit in the three different statistical distributions: (A) Maxwell-Boltzmann, (B) Bose-Einstein, and (C) Fermi-Dirac. Please answer A, B, C for (1) to (8). **(8 %)**

(1) Particles with 0 or integral spins
(2) Photons in a cavity
(3) Electrons in a metal
(4) Molecules of a gas
(5) Phonons in a solid
(6) Never more than 1 particles per state
(7) Particles far enough apart so wave functions do not overlap
(8) Identical, indistinguishable particles that obey exclusion principle

8. Please select "True" of "False" for the following descriptions. **(7 %)**

(1) In a n-type semiconductor, the number of holes in the valence band is much less than the number of electrons in the conduction band.
(2) In a n-type semiconductor, the current is usually contributed more from electrons than holes.
(3) In a p-type semiconductor, a small amount of an impurity that forms states located in the energy gap close to the edge of the conduction band.
(4) The intrinsic carrier concentration of a certain semiconductor material with bandgap of 0.7 eV is usually smaller than that of a certain semiconductor material with bandgap of 1.1 eV at room temperature.
(5) A certain semiconductor with bandgap of 1 eV is transparent to all visible light.
(6) The depletion region of a *pn* junction diode will be located less on the lightly-doped side than the heavily-doped side.
(7) The tunnel diode will have a larger tunneling current if the doping levels of the *pn* junction are reduced.

9. Please explain clearly from the semiconductor physics point-of-view that a diode formed by a *pn* junction can do the following functions.

(a) rectify current (i.e. current flow in one direction) **(5 %)**
(b) regulate voltage (i.e. small voltage variation with large current change) **(5 %)**

見背面

電子學 25%

10. You are the intern of TSMC and in charge of a CMOS fabrication line. One day you have a problem of threshold voltage shift in your transistors. Assume the threshold voltages of n-and p-channel MOSFETs, which are supposed to be +1 V and -1 V, respectively, are turning out to be +3 V and +1 V, instead. You suspect that the **interface** between the silicon and the 20 nm thick oxide is contaminated with ions.

(a) What type of device is each transistor now, enhancement mode (no channel when $V_{GS} = 0$) or depletion mode (strongly inverted when $V_{GS} = 0$)? Explain your answers. **(5 %)**

(b) What could be the sign of the ions, positive or negative? Explain your answers. **(5 %)**

11. Assume the transistor shown in Fig. 1 has $\beta = 50$.

(a) Find the value for R_C to obtain $V_C = +2V$. **(8 %)**

(b) What happens if the transistor is replaced with another having $\beta = 100$? Give the value of V_C in this case. **(7 %)**

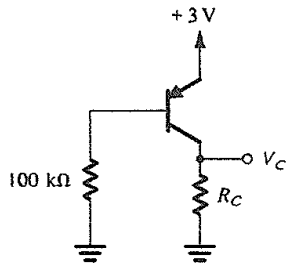

Fig. 1

試題隨卷繳回