

八十七學年度 材料科學工程研究所(系) 80 組碩士班研究生入學考試  
 近代物理(I) 科號 80 共 1 頁第 1 頁 請在試卷【答案卷】內作答

- (1) All definitions are arbitrary, but some are more useful than others. What is the objection to defining linear momentum as  $p = m_0 v$  instead of the more complicated  $p = m_0 v \sqrt{1 - v^2/c^2}$ . (3%)
- (2) Please show from special relativity that for an object of rest mass  $m_0$ , it's rest energy is  $m_0 c^2$ ,  $c$  is speed of light. (7%)
- (3) A spaceship has a speed that we measure to be  $0.2c$ . At one particular position, we measure no Doppler shift in the frequency of its radio transmissions. Specify this position. (10%)
- (4) In Compton scattering, one neglects the effect of the nucleus on the X-ray. Why? (5%)
- (5) Show that it is impossible for a photon to give up all its energy and momentum to a free electron. (10%)
- (6) The atoms in a solid possess a certain minimum zero-point energy even at  $0K$ , while no such restrictions holds for the molecules in an ideal gas. Use the uncertainty principle to explain these statements. (10%)
- (7) If the phase velocity is the same for all wavelengths of a certain wave phenomenon, please verify that the group and phase velocities are the same. (10%)
- (8) Please explain why the dark lines in an absorption spectrum are never totally dark. (5%)
- (9) (a) Please state the operating principles of the He-Ne laser.  
 (b) Explain why He-Ne laser can be operated in a continuous mode. (15%)
- (10) Show that the expectation values  $\langle px \rangle$  and  $\langle xp \rangle$  are related by

$$\langle px \rangle - \langle xp \rangle = \frac{\hbar}{i}. \quad (10\%)$$

- (11) What are the energy levels of a particle of mass  $m$  moving in one-dimensional potential

$$V(x) = \begin{cases} +\infty, & x < 0 \\ +\frac{m\omega^2 x^2}{2}, & x > 0 \end{cases}$$

No lengthy calculations are needed. (15%)