

國立彰化師範大學 100 學年度碩士班招生考試試題

系所：物理學系

組別：甲、乙組

科目：近代物理

☆☆請在答案紙上作答☆☆

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1. Explain the following terms briefly: (12%)

- (a) wave-particle duality
- (b) Stern-Gerlach experiment
- (c) Frank-Hertz experiment

2. A particle of mass m is confined to a one-dimension region, $0 \leq x \leq a$. At $t = 0$ its normalized

$$\text{wave function is } \psi(x,0) = \sqrt{\frac{8}{5a}} \left[1 + \cos\left(\frac{\pi x}{a}\right) \right] \sin\left(\frac{\pi x}{a}\right).$$

What is the average energy at a later time t ?

(15%)

3. A particle of mass m in the infinity square well ($0 < x < a$) has an initial wave function of the form

$\psi(x,0) = A \sin^3(\pi x/a)$, where A is a normalized constant. If we measure the energy, what values will be found and with what probabilities? (20%)

4. A particle of mass m moving in the finite square well potential: $V(x) = \begin{cases} 0 & x < |a| \\ V_0 & \text{otherwise} \end{cases}$.

Find the number of even and odd bound states when $V_0 = \frac{32\hbar^2}{ma^2}$. (15%)

5. An observer on earth sees a spaceship at an altitude of 600 km moving downward toward the earth with a speed $0.6c$

- (a) What is the altitude of the ship as measured by astronauts in the ship? (5%)
- (b) How soon will the ship hit the earth as calculated by the doomed astronauts? (5%)

6. What is the lowest possible energy an electron will have when it is trapped a vacancy in a crystal

lattice such that its motion is restricted to be spherical volume of radius 2.5 \AA ? (10%)

7. The ground state wavefunction of Hydrogen atom is given by $\frac{1}{\sqrt{\pi a_0^3}} e^{-r/a_0}$

- (a) Calculate the expectation value of r (6%)
- (b) Calculate the expectation value of $\hat{k}(xp_y - yp_x)_{op}$. (6%)
- (c) Calculate $\langle L_z y \rangle$ (6%)