國立清華大學106學年度碩士班考試入學試題

系所班組別：生命科學院丙組
考試科目（代碼）：近代物理(0702)

1. (10%) A particle of mass m moves in one dimension and the potential energy is
$$V(x) = \frac{1}{2}kx^2.$$
The energy levels are $E_n = (n + 1/2)h\nu$ where $n = 0, 1, 2, 3, ...$ and
$$\nu = \frac{1}{2\pi}\sqrt{k/m}.$$
If we change the potential energy to $U(x)$ such that $U(x) = V(x)$ for $x > 0$ but $U(x) = \infty$ for $x \leq 0$, what are the energy levels? You should explain how you derive your result.

2. (10%) A particle with mass m is confined in one-dimensional box between $x = 0$ and $x = L$. Apply the Heisenberg's uncertainty relation to determine the ground state energy E as a function of m, L, and h where h is the Planck's constant.

3. (10%) A particle of mass $3m$ decays at rest into two identical particles of mass m. Use the theory of relativity to calculate the final speed.

4. (5%) A large amount of energy is released in the center of the sun where two light nuclei (hydrogen isotopes) combine to form a helium nuclei. Explain why such process needs extremely high temperature.

5. (5%) consider a particle with mass m and speed v. What is the de Broglie wavelength of this particle?

6. (10%) Answer the following questions: (a) How many different kinds of quarks ? (b) What is the approximate age in years of the universe? (c) What is the approximate temperature at the center of sun? (d) Why a free neutron can not decay into a proton and and an electron? (e) What is the spin of a photon in unit of $h/2\pi$?

7. (10%) Explain the contents of two postulates of Einstein's special relativity.

8. (10%) Write down without proof the one-dimensional time-independent Schrodinger wave equation.

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9. (10%) Explain the photoelectric effect and explain the meaning of the work function of metal.

10. (20%) Explain (a) Chandrasekhar limit. (b) Compton effect. (c) Zeeman effect. (d) Stern-Gerlach experiment.