

系所組別： 物理學系

考試科目： 近代物理學

考試日期： 0226，節次： 3

1. (a) What is the 'proper time' in special theory of relativity? (10%) (b) The muon lifetime at rest is about $2.22 \mu\text{s}$. What is the lifetime of a cosmic ray produced muon traveling at 98% of the speed of light? (10%)
2. Show that a free electron cannot absorb a photon and conserve both energy and momentum in the process. Hence, the photoelectric process requires a bound electron. (20%)
3. Consider a body rotating freely about a fixed axis. Apply Wilson-Sommerfeld quantization rules to find out the possible values of the total energy. (Express it with moment of inertia) (20%)
4. The *time-independent* wavefunction $\Psi(x)$ for the second excited energy state of a simple harmonic oscillator, consisting of a particle of mass m acted on by a linear restoring force of force constant C , can be expressed as $\psi_2(x) = A_2(1 - 2u^2)e^{-u^2/2}$, where u is related to the Coordinate x by the equation $u = [(Cm)^{1/4} \eta^{1/2}]x$. (a) Find out the corresponding Eigen-energy of this state. (10%) (b) Evaluate the expectation value of the momentum p . (10%)
5. Consider a particle moving in the potential $V(x)$ illustrated in the figure, that has a rectangular region of depth V_0 , and width a . (a) Make a quantitative calculation of the transmission coefficient for an unbound particle moving over such a potential. (10%) (b) Find the condition on the total energy of the particle which makes the transmission coefficient equal to one. (10%)

