

國立中央大學101學年度碩士班考試入學試題卷

所別：物理學系生物物理碩士班 不分組(一般生) 科目：普通物理 共 / 頁 第 / 頁

本科考試禁用計算器

*請在試卷答案卷(卡)內作答

Note: All your numerical answers must have at least 2 significant figures.

- (15pts) Water from a hose emerges at 5 m/s horizontally and strikes a wall and then dribbles down. The flow rate is 0.5 kg/s. Please estimate the average force on the wall.
- (15pts) A small insect propels its body (≈ 2 g) from rest to 3.0 m/s in 3 cm. Please estimate the average power output of its legs during this event.
- (15pts) Please explain why the capacitance becomes larger when dielectric media is inserted into the empty space.
- (15pts) White light is incident normally on a lens ($n = 1.5$) that is coated above with a film of MgF_2 ($n \approx 1.4$). For what minimum thickness of the film will blue light of wavelength 460 nm (in air) be missing in the reflected light?
- (15pts) A certain cloud is made up of charged raindrops each carrying a positive charge of $e = 1.6 \times 10^{-19}$ Coulombs. There are n raindrops per m^3 and the cloud is assumed spherical.
 - (7pts) Using Gauss' Law, find the electric field on the surface of the cloud in terms of n and the radius of the sphere r (assuming spherical symmetry).
 - (8pts) When the electric field builds up to $E = 3 \times 10^6$ volts/m lightning will discharge from the cloud. If $n = 10^{10}/\text{m}^3$, how large (in radius) must the cloud be before one sees lightning? ($\epsilon_0 = 8.85 \times 10^{-12}$ Coulomb²/N·m²) (If your answer appears unreasonable, that may possibly imply that the discharge is due to some other mechanism.)
- (25pts) 'Sound' means waves that result from compression and rarefaction of the air or other materials. The compression and rarefaction are quite fast such that the physics therein can be described approximately by adiabatic processes, where $PV^\gamma = \text{constant}$ for the case of ideal gases.
 - (9pts) The air can be treated as a diatomic ideal gas, where $\gamma = 7/5$. Find the bulk modulus of air for adiabatic processes at pressure P and absolute temperature T .
 - (8pts) Following the result of (a), find the speed of sound in air. (The average molecular weight of air is M , and the ideal-gas constant is R , as all these quantities are in SI units.)
 - (8pts) A cello string has a mass m and is to be stretched between supports L meters apart. The tension is adjusted until the wavelength of the fundamental on the string is equal to the wavelength of the same sound (in frequency) in air. Please estimate the tension in the string.