國　立　清　華　大　學　命　題　紙

九十二學年度 物理、天文 系（所）＿＿＿＿ 組碩士班研究生招生考試

科目 普通物理 科號 0401 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

普通物理

請注意: 1,請按題目順序作答.

2,填充題不需要寫計算過程.

3, moment of inertia of a thin uniform rod $I_{cm} = mL^2/12$,

1 atm = 1.01×10^5 Pa, $k_B = 1.38 \times 10^{-23}$ J/K.

I. 填充題(每空三分, 依號碼順序填寫在試卷上):

1. 在地球表面空氣分子的密度約爲＿＿(1)＿＿＿＿ /m^3，其自由路徑 (mean free path) 約爲＿＿(2)＿＿＿＿m. (只須寫數量級)
2. 一極大水箱中水面高度 H 保持不變,在水面下深 h 處有一小孔.水自小孔水平射出,到達地面時之垂直速度分量爲＿＿(3)＿＿，距箱邊水平距離爲＿＿(4)＿＿.
3. 一行星對一恒星的運行軌道爲橢圓，設行星質量遠小於恒星的質量,行星與恒星間之最近距離爲 r，最遠距離爲 R,則行星的動能與位能之比值在最近點爲＿＿(5)＿＿＿＿，在最遠點爲＿＿(6)＿＿＿＿.
4. 一均勻細桿長 L，質量 m,自垂直立於地面狀態倒下，接觸地面一端不動.則當細桿另一端碰到地面時之速率爲＿＿(7)＿＿＿＿.
5. 以小於狹縫 (slit) 寬度的波長照射四個等距狹縫， 若兩相鄰狹縫間的相位差爲 Φ， 則其繞射條紋中第一極小的 Φ 爲＿＿(8)＿＿＿＿.
6. 八個相同電荷 Q 分別座落在正方形邊長爲 L 的各角上,其鄰近三邊各平行 $\hat{i}$, $\hat{j}$, $\hat{k}$，則在 $\vec{r} = L\hat{i} + L\hat{j} + L\hat{k}$ 的電荷所受的淨力爲＿＿(9)＿＿＿＿.
7. 有一半徑爲 R 的半圓形導線,載有電流 I，當把它置於垂直圓形面的均勻磁場 B 中時， 導線所受力的大小爲＿＿(10)＿＿＿＿.
8. 一靜止質量 m_0 之粒子若具有動量 m_0c (c 爲光速),則此粒子之速率爲＿(11)＿，總能量爲＿(12)＿＿＿.
9. 若能量爲 1.24 keV 的光子其波長爲 1.00 nm， 則具能量爲 3.1 keV 的光子,其波長爲＿(13)＿＿nm。若具動能爲 144 eV 的電子， 其 de Broglie 波長爲 0.10 nm， 則動能爲 64 eV 的電子，其 de Broglie 波長爲＿(14)＿＿nm.

II. 計算題 (前四題十二分， 第五題十分)

1. A thin uniform rod of mass m and length L, originally at rest, is free to slide on a frictionless horizontal surface. A bullet of mass m and initial speed v hits perpendicularly and is embedded in the end of the rod (Fig. 1). Find (a) the angular momentum of the rod-bullet system around their center of mass immediately before the bullet hits the rod, (b) the speed of the center of mass of the system after the collision, (c) the angular speed around the center of mass of the system after the collision, and (d) the

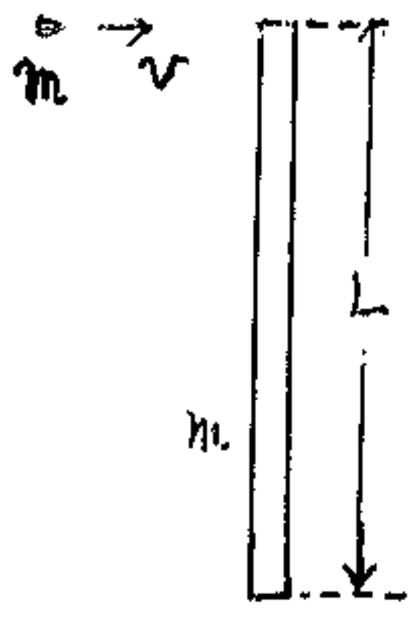

Fig 1

energy loss during the collision. (2, 2, 5, 3)%

2. The working substance of a thermal engine is one mole of monatomic ideal gas. The operating path is shown in the right figure (Fig. 2). Find (a) the work done in each process and in a cycle, (b) the heat absorbed or liberated in each process and in a cycle, and (c) the efficiency of this engine. [Express the results in (a) and (b) in terms of p_0 and V_0] (5, 5, 2)%

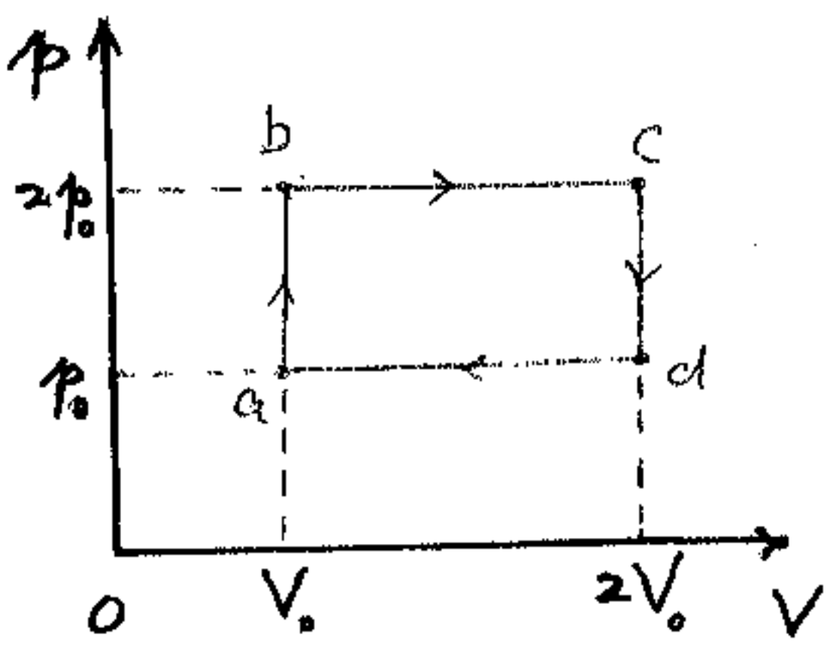

Fig. 2

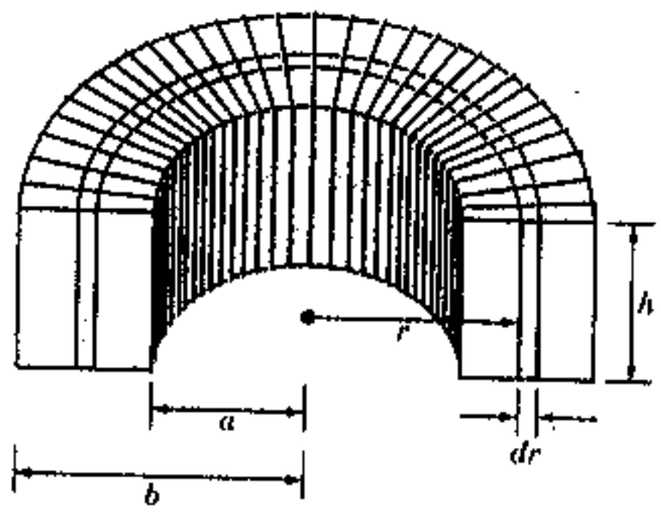

Fig. 3

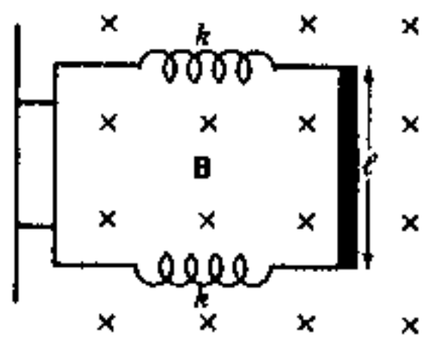

Fig. 4

3. A *toroidal coil* (shaped like a doughnut) with height h, inner radius a and outer radius b is tightly wound with N turns and carries a current I. We assume that it has a rectangular cross section, as shown in Fig. 3. Find (a) the field strength within the toroid in terms of r; (b) the total energy within the toroid; (c) The self-inductance of the toroid. (4, 4, 4)%
4. A conducting loop is formed with two springs with spring constant k and a rod of length ℓ and mass m, as shown in Fig. 4. A uniform magnetic field of B is directed perpendicular to the plane of the loop. At t = 0, the rod is released with the springs extended by A. (a) Find the equivalent spring constant. (b) Write an expression for the induced emf, $\varepsilon(t)$. (c) What is the maximum value of the emf, and when does it occur for the first time? (2, 5, 5)%
5. A particle of mass m is confined to an infinite well of width L in one dimension. The potential energy is zero within the well. The wave function of the particle has the form

$$\psi(x) = A \sin(n\pi x/L), \qquad n = 1,2,3,.....$$

(a) Find A. (b) What is the quantized total energy? (c) If the particle is in its ground state, what is the probability that the particle will be found between x = 0 and x = L/2? (3, 4, 3)%