

科目：普通物理 適用：應化系二

編號：342

考生注意：

1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 限用藍、黑色筆作答；試題須隨卷繳回。

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- 1 (30%) A neutral water molecule ( $\text{H}_2\text{O}$ ) in its vapor state has an electric dipole moment of magnitude  $6.2 \times 10^{-30} \text{ C}\cdot\text{m}$ . (Remark:  $e = 1.6 \times 10^{-19} \text{ C}$ ,  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$ )
- (a) How far apart are the molecule's centers of positive and negative charge?
  - (b) If the molecule is placed in an electric field of  $3.0 \times 10^4 \text{ N/C}$ , what maximum torque and the field exert on it?
  - (c) How much work must an external agent do to rotate this molecule by  $180^\circ$  in this field, starting from its fully aligned position, for which  $\theta = 0^\circ$ .
- 2 (36%) As shown is Figure 2, a parallel-plate capacitor of plate area  $A$  and plate separation  $d$ . A potential difference  $V_0$  is applied between the plates. The battery is then disconnected, and a dielectric slab of thickness  $b$  and dielectric constant  $\kappa$  is placed between the plates. (Assume  $A = 120 \text{ cm}^2$ ,  $d = 1.6 \text{ cm}$ ,  $V_0 = 100 \text{ V}$ ,  $b = 1.0 \text{ cm}$ ,  $\kappa = 2.6$ ,  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$ .)
- (a) What is the capacitance  $C_0$  before the dielectric slab is inserted?
  - (b) What free charge appears on the plates before the dielectric slab is inserted?
  - (c) What is the electric field  $E_0$  in the gap between the plates and the dielectric slab?
  - (d) What is the electric field  $E_1$  in the dielectric slab?
  - (e) What is the potential difference  $V$  after the dielectric slab has been inserted?
  - (f) What is the capacitance  $C_1$  after the dielectric slab has been inserted?
- 3 (20%) In Figure 3, particle  $A$  moves along the line  $y = 30 \text{ m}$  with a constant velocity  $\vec{v} = 3.0 \text{ m/s}$  and parallel to the  $x$  axis. At the instant particle  $A$  passes the  $y$  axis, particle  $B$  leaves the origin with zero initial speed and constant acceleration  $\vec{a} = 0.40 \text{ m/s}^2$ .
- (a) What angle  $\theta$  between  $\vec{a}$  and the positive direction of the  $y$  axis would result in a collision? and
  - (b) when will the collision take place?
- 4 (14%) A cylinder contains  $12 \text{ L}$  of oxygen at  $20^\circ\text{C}$  and  $15 \text{ atm}$ . The temperature is raised to  $35^\circ\text{C}$ , and the volume is reduced to  $8.5 \text{ L}$ . Assume that the gas is ideal. What is the final pressure of the gas in atmosphere?

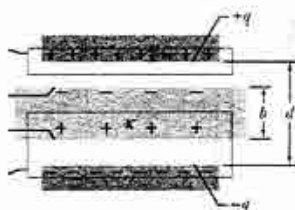


Figure 2

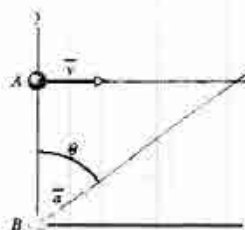


Figure 3