

第十五章：气体定律 (2003年 - 2017年)

选择题

① $P = 76 \text{ cmHg} + 20 \text{ cmHg}$
 $= 96 \text{ cmHg}$

B

② $\downarrow \frac{V_A}{T_A} = \frac{V_B}{T_B} \uparrow$

A

③ $PV = nRT$

A

④ $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
 $\frac{1.5 \times 10^5 \times 2.8 \times 10^{-3}}{(273+69)} = \frac{1 \times 10^5 \times V_2}{(10+273)}$

$V_2 = 3.35 \times 10^{-3} \text{ m}^3$

C

⑤ $P_1 V_1 = P_2 V_2$
 $P_1 (A \times h_1) = P_2 (A \times h_2)$
 $(76+5) \times 94 = (76-5) h_2$
 $h_2 = 16 \text{ cm}$

D

⑥ $\frac{V_1}{T_1} = k$
 $V_1 = k T_1$

C

⑦ $P_1 V_1 = P_2 V_2$
 $P_1 (A h_1) = P_2 (A h_2)$
 $(75-15) \times 12 = 75 h_2$
 $h_2 = 9.6 \text{ cm}$

B

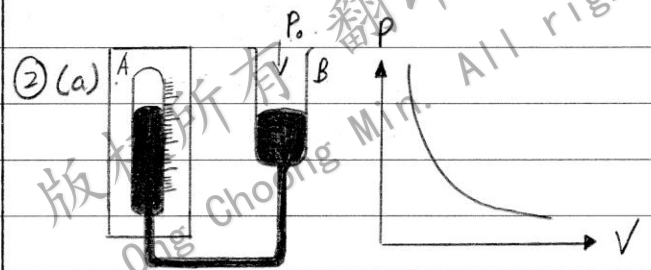
- ⑧ $a \rightarrow d$ (定容过程, $\frac{\uparrow P}{\uparrow T} = k$, 压强增大)
 $b \rightarrow d$ ($\frac{V}{T} = k$, 定压过程)
 $c \rightarrow d$ (定温过程, $\downarrow PV \uparrow = k$, 压强减少)
 B

⑨ $\uparrow PV \uparrow = \bar{n} RT \uparrow$
 C

⑩ $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
 $\frac{150 \times 2}{(20+273)} = \frac{250 \times V_2}{(30+273)}$
 $V_2 = 1.24 \text{ m}^3$

⑪ C

作答题
 ① $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
 $\frac{P_1}{P_1} = \frac{P_2}{P_1 + \frac{1}{100} P_1}$
 $\frac{T_1}{T_1 + 5} = \frac{101}{100} \frac{P_1}{P_1}$
 $T_1 + 5 = \frac{101}{100} T_1$
 $\frac{1}{100} T_1 = 5$
 $T_1 = 500 \text{ K}$



② (a) 记录 A、B 两管水银面的刻度, 测出空气柱长度 l_1 , 此时空气压强即为大气压强 P_0 . 提高或降低 B 管, A 管水银面达到另一刻度 M_1 , 而 B 管水银面达到另一刻度 N_1 , 空气柱的长度为 l_2 , 空气压强 $P_2 = P_0 + M_1 N_1$, 记录 5 组相应的空气柱长度 l 及压强 P .

$$(b) (i) P = 76 \text{ cmHg} - 70 \text{ cmHg} \\ = 6 \text{ cmHg} \#$$

$$(ii) P_1 V_1 = P_2 V_2 \\ P_1 (A h_1) = P_2 (A h_2) \\ 6 \times 30 = P_2 (100 - 68) \\ P_2 = 5.625 \text{ cmHg}$$

$$P = 68 \text{ cmHg} + 5.625 \text{ cmHg} \\ = 73.6 \text{ cmHg} \#$$

$$(iii) \frac{P_1}{T_1} = \frac{P_2}{T_2}, V \text{ 是固定} \\ \frac{6}{27+273} = \frac{P_2}{273-3} \\ P_2 = 5.4 \text{ cmHg}$$

$$P = 5.4 \text{ cmHg} + 70 \text{ cmHg} \\ = 75.4 \text{ cmHg} \#$$

$$(ii) I: \frac{P_1}{T_1} = \frac{P_2}{T_2} \quad II: \frac{P_1}{T_1} = \frac{P_2}{T_2} \\ P_2 = \frac{T_2}{T_1} \times P_1 \quad P_2 = \frac{T_2}{T_1} \times P_1 \\ = \frac{330}{300} P_1 \quad = \frac{550}{400} P_1$$

$\frac{550}{400} P_1 > \frac{330}{300} P_1$, 区域II的压强大于区域I的压强, 所以活塞将会往左移动。

(iii) 设活塞向左移动 x .

$$F'_I = F'_II$$

$$P'_I A_I = P'_II A_{II}$$

$$\frac{n_I R T_I}{A_I L_I} A_I = \frac{n_{II} R T_{II}}{A_{II} L_{II}} A_{II}$$

$$\frac{n_I}{L_I T_I} = \frac{n_{II}}{L_{II} T_{II}}$$

$$\frac{2}{3} = \frac{550 \times (L - x)}{330 \times (L + x)}$$

$$\frac{2}{3} = \frac{550 \times (35 - x)}{330 \times (70 + x)}$$

$$660(70 + x) = 1650(35 - x)$$

$$x = 5 \text{ cm} \#$$

③ (a) 一种气体, 不管其压强、温度的高低, 总是完全遵守这些简单的规律, 这种气体就称作理想气体。

理想气体状态方程式:

$$PV = nRT$$

P = 气体的压强

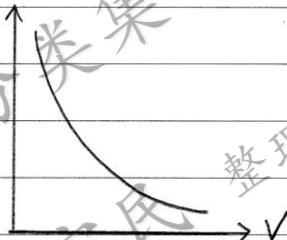
V = 气体的体积

n = 摩尔数

R = 气体常数

T = 温度

④ (a) P



一定的气体, 在温度不变的情况下, 它的压强跟体积成反比。

(b) 0°C 压强为 P_1

14°C 压强为 P_2

15°C 压强为 P_3

$$(b) (i) F_1 = F_2 \\ P_1 A_1 = P_2 A_2 \\ \frac{n_1 R T_1}{A_1 L_1} A_1 = \frac{n_2 R T_2}{A_2 L_2} A_2 \\ \frac{n_1}{L_1 T_1} = \frac{n_2}{L_2 T_2} \\ = \frac{400 \times 35}{70 \times 300}$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad \frac{P_1}{T_1} = \frac{P_3}{T_3} \\ \frac{P_1}{273} = \frac{P_2}{14+273} \quad \frac{P_1}{273} = \frac{P_3}{15+273} \\ P_2 = \frac{41}{39} P_1 \quad P_3 = \frac{96}{91} P_1$$

$$P_3 - P_1 = \frac{96}{91} P_1 - \frac{41}{39} P_1 = \frac{1}{273} P_1 \#$$

$$\begin{aligned}
 (c) \quad P_1 V_1 &= P_2 V_2 \\
 75 \times 100 &= [75 + (50 - h)] (100 - h) \\
 7500 &= (125 - h) (100 - h) \\
 7500 &= 12500 - 125h - 100h + h^2 \\
 0 &= h^2 - 225h + 5000 \\
 h &= 25 \text{ cm} \#
 \end{aligned}$$

$$\begin{aligned}
 (d) \quad PV &= nRT \\
 PV &= \frac{m}{M} RT \\
 m &= \frac{PV M}{RT} \\
 &= \frac{1.37 \times 10^5 \times 0.0566 \times 32}{8.31 \times (27 + 273)} \\
 &= 9.95 \times 10^3 \text{ g} / 9.95 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 (6) \quad P_A &= P_B \\
 \frac{n_A R T_A}{V_A} &= \frac{n_B R T_B}{V_B} \\
 \frac{V_B}{V_A} &= \frac{n_B T_B}{n_A T_A} \\
 &= \frac{(7 + 273)}{(27 + 273)} \times \frac{n_B}{n_A} \\
 &= \frac{14}{15} \times \frac{n_B}{n_A} / 0.933 \frac{n_B}{n_A} \#
 \end{aligned}$$

$$\begin{aligned}
 P'_A &= P'_B \\
 \frac{n_A R T'_A}{V'_A} &= \frac{n_B R T'_B}{V'_B} \\
 \frac{V'_B}{V'_A} &= \frac{n_B T'_B}{n_A T'_A} \\
 &= \frac{(17 + 273)}{(42 + 273)} \times \frac{n_B}{n_A} \\
 &= \frac{58}{53} \times \frac{n_B}{n_A} / 0.921 \frac{n_B}{n_A} \#
 \end{aligned}$$

$\therefore B$ 的体积变小, 所以水银柱向右移动。

⑤ (a) 完全遵守压强、体积及温度间的变化规律的气体, 称为理想气体。

$$\begin{aligned}
 (b) \quad \text{斜率} &= \frac{y_2 - y_1}{x_2 - x_1} \\
 \frac{y_B - 1.2}{300 - 0} &= \frac{1.2 - 0}{0 + 273} \\
 y_B &= 2.52 \\
 V_B &= 2.52 \text{ m}^3 \#
 \end{aligned}$$

$$\begin{aligned}
 PV &= nRT \\
 P_B \times 2.52 &= 0.5 \times 8.31 \times (300 + 273) \\
 P_B &= 945.26 \text{ Pa} \#
 \end{aligned}$$

$$\begin{aligned}
 (c) (i) (ii) \quad P_0 V_0 &= P_1 V_1 \\
 76 \times 50 &= (76 + h) h \\
 3800 &= 76h + h^2 \\
 0 &= h^2 + 76h - 3800 \\
 h &= 34.42 \text{ cm}
 \end{aligned}$$

$$\begin{aligned}
 \therefore h &= 34.42 \text{ cm} \# ; P_1 = 76 \text{ cmHg} + 34.42 \text{ cmHg} \\
 &= 110.42 \text{ cmHg} \#
 \end{aligned}$$