试卷参考答案

一、填充题：（12 题，共 48 分）

1. $v=v_0+bt$ $\quad a_t=\dfrac{\mathrm{d}v}{\mathrm{d}t}=b$ $\quad a_n=\dfrac{v^2}{R}=\dfrac{(v_0+bt)^2}{R}$

$a=\sqrt{a_t^2+a_n^2}=\sqrt{b^2+\dfrac{(v_0+bt)^4}{R^2}}$

2. $\sum F=mg-kv^2=ma=0$ $\quad v=\sqrt{\dfrac{mg}{k}}$

3. $kx=mg$ $\quad A=\int_0^x kx\mathrm{d}x=\dfrac{1}{2}kx^2=\dfrac{m^2g^2}{2k}$

4. $\Delta t=\dfrac{L_0\sqrt{1-v^2/c^2}}{v}=\dfrac{135}{2c}=2.25\times10^{-7}(\mathrm{s})$ $\quad \Delta t'=\dfrac{L_0}{v}=\dfrac{225}{2c}=3.75\times10^{-7}(\mathrm{s})$

5. $A=m_2c^2-m_1c^2=m_0c^2\left(\dfrac{1}{\sqrt{1-v_2^2/c^2}}-\dfrac{1}{\sqrt{1-v_1^2/c^2}}\right)=4.72\times10^{-14}(\mathrm{J})$

6. $\Delta\varphi=\pi$ $\quad \Delta t=\dfrac{\Delta\varphi}{\omega}=\dfrac{\pi}{2\pi}=\dfrac{1}{2}(\mathrm{s})$

7. $\Delta\varphi=\varphi_2-\varphi_1-\dfrac{2\pi}{\lambda}[\overline{S_2C}-(\overline{S_1S_2}+\overline{S_2C})]=(2k+1)\pi$

$\varphi_2-\dfrac{\pi}{2}-\dfrac{2\pi}{\lambda}\times\dfrac{3}{2}\lambda=(2k+1)\pi$ $\quad \varphi_2=\dfrac{\pi}{2}$

$\Delta\varphi=\varphi_2-\varphi_1=(2k+1)\pi$ $\quad \varphi_2=\dfrac{3\pi}{2}$

8. $\nu=\dfrac{330+30}{330+25}\cdot600=659\,(\mathrm{Hz})$

9. $\bar{l}=\sqrt[3]{\dfrac{1}{n}}=\sqrt[3]{\dfrac{kT}{p}}=3.34\times10^{-9}(\mathrm{m})$

10. $Q<Q_{ab}$ $\quad \Delta S_{ab}=\Delta S_{acb}$（熵是状态函数）

11. $\dfrac{\lambda}{2\pi\varepsilon_0 a}\sin\dfrac{\pi}{6}=\dfrac{Q}{4\pi\varepsilon_0 a^2}$ $\quad \lambda=\dfrac{Q}{a}$ $\quad$ 异号

12. $\dfrac{1}{2}\rho_{气}v^2=\rho_{水银}gh$ $\quad v=200\,(\mathrm{m/s})$

二、计算题：（6 题，共 52 分）

1.（1） $mg-T=ma$ $\quad T_1r-T_2r=J\beta_1$ $\quad a=\beta_1 r$

$T_2R=\dfrac{2}{5}MR^2\beta_2$ $\quad a=\beta_2R$ $\quad a=\dfrac{mg}{m+2M/5+J/r^2}$

（2） $v^2=2ah$ $\quad v=\sqrt{\dfrac{2mgh}{m+2M/5+J/r^2}}$

2.（1）　$L = J\omega = 2.0\,(\mathrm{kg\cdot m^2/s})$　　方向沿自转轴向下

（2）　$M = \left|\vec{r}\times\vec{F}\right| = mgr\sin\theta = 0.98\,(\mathrm{N\cdot m})$

（3）　$M = \left|\vec{\Omega}\times\vec{L}\right| = \Omega L\sin\theta$　　$\Omega = \dfrac{M}{L\sin\theta} = 0.98\,(\mathrm{rad/s})$

3.（1）　$A = \dfrac{1}{2}(3+1)(3-1)\times 1.013\times 10^5\times 10^{-3} = 405.2\,(\mathrm{J})$

（2）　$T_a = T_c$　　$\Delta E = 0$

（3）　$Q_{净} = A = 405.2\,(\mathrm{J})$

$\dfrac{p-p_a}{V-V_a} = \dfrac{p_b-p_a}{V_b-V_a}$　　$p = 4-V$（采用图中单位）

$(4-V)V = \nu RT$（状态方程）　　$\mathrm{d}Q = p\mathrm{d}V + \nu C_V\mathrm{d}T$（热力学第一定律）

吸放热转换点（$\mathrm{d}Q = 0$）d的状态参量为（$i = 5$）：$p_d = \dfrac{5}{3}\,(\mathrm{atm})$，$V_d = \dfrac{7}{3}\,(\mathrm{L})$。则吸热：

$$Q_{ad} = \Delta E_{ad} - A_{ad} = \frac{i}{2}\nu R(T_d - T_a) + A_{da} = \frac{5}{2}(p_dV_d - p_aV_a) + \frac{1}{2}(p_d + p_a)(V_d - V_a) = 540.3\,(\mathrm{J})$$

放热：　$Q_{dc} = Q_{ad} - Q_{净} = 540.3 - 405.2 = 135.1\,(\mathrm{J})$

4.　　$Q = I^2Rt$　　$Q_V = Q_p$　　$Q_V = \nu C_V(T_1 - T_0)$　　$Q_p = \nu C_p(T_2 - T_0)$

$$\gamma = \frac{C_p}{C_V} = \frac{T_1 - T_0}{T_2 - T_0} = \frac{\dfrac{p_1}{p_0}T_0 - T_0}{\dfrac{V_1}{V_0}T_0 - T_0} = \frac{(p_1 - p_0)V_0}{(V_1 - V_0)p_0}$$

5.　　$\omega = 4\pi\,(\mathrm{rad/s})$　　$k = \dfrac{\omega}{u} = \dfrac{\pi}{5}\,(\mathrm{rad/m})$

（1）　$y = 0.3\cos(4\pi t + \dfrac{\pi}{5}x - \pi)$ (m)　　$x_D = -9\,(\mathrm{m})$　　$y_D = 0.3\cos(4\pi t - \dfrac{14}{5}\pi)$ (m)

（2）　$\varphi = \varphi_A + kx = -\pi + \dfrac{\pi}{5}\cdot 5 = 0$　　$y = 0.3\cos(4\pi t - \dfrac{\pi}{5}x)$ (m)

$x_D = -14\,(\mathrm{m})$　　$y_D = 0.3\cos(4\pi t - \dfrac{14}{5}\pi)$ (m)

6.（1）　$\Phi_{外} = \oint_S \vec{E}_{外}\cdot\mathrm{d}\vec{S} = E_{外}\cdot 2\pi rl = \dfrac{\rho\cdot\pi R^2 l}{\varepsilon_0}$　　$E_{外} = \dfrac{\rho R^2}{2\varepsilon_0 r}$

（2）　$\Phi_{内} = \oint_S \vec{E}_{内}\cdot\mathrm{d}\vec{S} = E_{内}\cdot 2\pi rl = \dfrac{\rho\cdot\pi r^2 l}{\varepsilon_0}$　　$E_{内} = \dfrac{\rho r}{2\varepsilon_0}$

（3）当$r = R$时，E最强；当$r = 0$或$r = \infty$时，E最弱。