# 试卷参考答案

## 一、填充题：（12 题，共 48 分）

1．$v = v_0 + \int_0^t Ct^2 \mathrm{d}t = v_0 + \frac{1}{3}Ct^3$　　$x = x_0 + v_0 t + \frac{1}{12}Ct^4$

2．$m_1 v_1 = m_2 v_2$　　$E_\mathrm{p} = \frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2 = \frac{1}{2}m_1 \frac{m_1 + m_2}{m_2} v_1^2$

3．$m_1 \omega_1 r_1^2 = m_2 \omega_2 r_2^2$　　$\Delta E_\mathrm{k} = \frac{1}{2}J_2\omega_2^2 - \frac{1}{2}J_1\omega_1^2 = \frac{1}{2}mr_1^2(\frac{r_1^2}{r_2^2} - 1)\omega_1^2$

4．$x_2 = A\cos(\omega t + \alpha - \frac{\pi}{2})$

5．$y_2 = 2.0\times 10^{-2}\cos[100\pi(t - \frac{x}{20}) - \frac{4\pi}{3}]$

6．$S = a\sqrt{1 - v^2/c^2}\cdot b$　　$\sigma = \frac{m}{S} = \frac{m_0}{ab(1 - v^2/c^2)}$

7．$A = \Delta E_\mathrm{k} = m_0c^2(\frac{1}{\sqrt{1 - v_2^2/c^2}} - \frac{1}{\sqrt{1 - v_1^2/c^2}}) = m_0c^2(\frac{1}{\sqrt{1 - 0.8^2}} - \frac{1}{\sqrt{1 - 0.4^2}}) = 4.7\times 10^{-14}(\mathrm{J})$

8．B

9．$\bar{\varepsilon}_t = \frac{3}{2}kT$　　$\bar{\varepsilon}_{t\mathrm{H}_2} / \bar{\varepsilon}_{t\mathrm{O}_2} = 1$　　$\sqrt{\overline{v^2}} = \sqrt{\frac{3RT}{M}}$　　$\sqrt{\overline{v^2}}_{\mathrm{H}_2} / \sqrt{\overline{v^2}}_{\mathrm{O}_2} = 4$

10．$\bar{Z} \propto n\bar{v} \propto \frac{p}{T}\cdot\sqrt{T}$　　$p = 2p_0$　　$T = 4T_0$　　$\bar{Z}/\bar{Z}_0 = 1$

11．$\Delta\nu = \frac{340}{340 - v_\mathrm{s}}\nu - \frac{340}{340 + v_\mathrm{s}}\nu$　　$v_\mathrm{s} \approx \frac{\Delta\nu}{2\nu}\cdot 340 = 0.25\,(\mathrm{m/s})$

12．$E = \int_0^L \frac{\lambda \mathrm{d}x}{4\pi\varepsilon_0(L + a - x)^2} = \frac{\lambda L}{4\pi\varepsilon_0 a(L + a)}$

## 二、计算题：（6 题，共 52 分）

1．（1）　$mv_0 l = mvl + J\omega$　　$\frac{1}{2}mv_0^2 = \frac{1}{2}mv^2 + \frac{1}{2}J\omega^2$

$Mg\frac{l}{2}(1 - \cos\theta) = \frac{1}{2}J\omega^2$　　$J = \frac{1}{3}Ml^2$

$\omega = \sqrt{\frac{3g}{l}(1 - \cos\theta)}$　　$v_0 = \frac{1}{2}(1 + \frac{M}{3m})\sqrt{3gl(1 - \cos\theta)}$

（2）　$\int M\mathrm{d}t = J\omega - 0 = \frac{Ml}{3}\sqrt{3gl(1 - \cos\theta)}$

2．　$mg(h - 2R) = \frac{1}{2}mv^2 + \frac{1}{2}J\omega^2$　　$J = \frac{2}{5}mr^2$

$mg + N = m\frac{v^2}{R}$　　$N \geq 0$　　$v = r\omega$　　$h \geq \frac{27}{10}R$

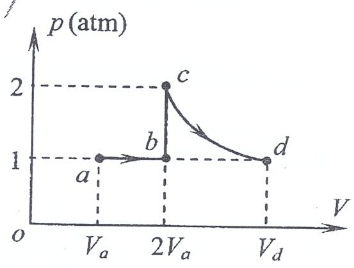
3.（1） $f(v)=\begin{cases} av/v_0 & 0\le v\le v_0 \\ a & v_0\le v\le 2v_0 \\ 0 & v>2v_0 \end{cases}$

（2） $\int_0^{v_0}\frac{a}{v_0}v\mathrm{d}v+\int_{v_0}^{2v_0}\frac{a}{v_0}v\mathrm{d}v=1 \qquad a=\frac{2}{3v_0}$

（3） $\Delta N=\int_{0.5v_0}^{1.2v_0}f(v)\mathrm{d}v=N\int_{0.5v_0}^{v_0}\frac{a}{v_0}v\mathrm{d}v+N\int_{v_0}^{1.2v_0}a\mathrm{d}v=\frac{23}{60}N$

（4） $\bar{v}=\int_0^{\infty}vf(v)\mathrm{d}v=\int_0^{v_0}\frac{a}{v_0}v^2\mathrm{d}v+\int_{v_0}^{2v_0}a\mathrm{d}v=\frac{11}{9}v_0$

4. $i=5 \qquad p_{a,b,d}=1\ (\mathrm{atm})$




$p_c=2\ (\mathrm{atm}) \qquad T_a=300\ (\mathrm{K})$

$T_b=2T_a \qquad T_{c,d}=4T_a$

$\Delta E=\nu C_V(T_d-T_a)=\frac{5}{2}R(4T_a-T_a)=1.87\times10^4\,(\mathrm{J})$

$A=p_a(2V_a-V_a)+\nu RT_c\ln\frac{p_c}{p_d}=RT_a(1+4\ln 2)=9.41\times10^3\,(\mathrm{J})$

$Q=\Delta E+A=2.81\times10^4\,(\mathrm{J})$

$\Delta S=\nu C_p\ln\frac{T_b}{T_a}+\nu C_V\ln\frac{T_c}{T_b}+\nu R\ln\frac{p_c}{p_d}=7R\ln 2=40.32\ (\mathrm{J/K})$

5.（1） $\sqrt{2}A/2=A\cos\varphi \qquad v_0=-A\omega\sin\varphi<0$

$\varphi=\frac{\pi}{4} \qquad y_0=A\cos(500\pi t+\frac{\pi}{4})\ \ (\mathrm{SI})$

$\lambda=200\ (\mathrm{m}) \qquad y=A\cos[2\pi(250t+\frac{x}{200})+\frac{\pi}{4}]\ \ (\mathrm{SI})$

（2） $y_{100}=A\cos(500\pi t+\frac{5}{4}\pi) \qquad v_{100}=-500\pi A\sin(500\pi t+\frac{5}{4}\pi)$

6. $\oint_S\vec{E}\cdot\mathrm{d}\vec{S}=E\cdot4\pi r^2=\frac{1}{\varepsilon_0}(Q+\int_a^r\frac{A}{r}\cdot4\pi r^2\,\mathrm{d}r)=\frac{1}{\varepsilon_0}[Q+2\pi A(r^2-a^2)]$

$E=\frac{Q}{4\pi\varepsilon_0 r^2} \qquad (0<r\le a)$

$E=\frac{Q+2\pi A(r^2-a^2)}{4\pi\varepsilon_0 r^2} \qquad (a\le r\le b)$

$E=\frac{Q+2\pi A(b^2-a^2)}{4\pi\varepsilon_0 r^2} \qquad (r\ge b)$