试卷参考答案

一、填充题：（12 题，共 48 分）

1. $v=\int_0^6 5(5-2t)\mathrm{d}t=5(5t-t^2)\big|_0^5=0$

2. $\vec{I}=(mv_{Bx}-mv_{Ax})\vec{i}+(0-mv_{Ay})\vec{j}=-mv[(1+\cos\frac{\pi}{4})\vec{i}+\sin\frac{\pi}{4}\vec{j}]$

   $I=\sqrt{I_x^2+I_y^2}=0.739\ (\mathrm{N\cdot s})$

3. $m'=4m\frac{(R/2)^2}{R^2}=m$　　$J_o=\frac{1}{2}4mR^2-(\frac{1}{2}m\frac{R^2}{4}+m\frac{R^2}{4})=\frac{13}{8}mR^2$

4. $l=l_0\sqrt{1-v^2/c^2}=v\Delta t$　　$v=\frac{l_0/\Delta t}{\sqrt{1+(l_0/c\Delta t)^2}}=\frac{6}{\sqrt{5}}\times10^8=2.68\times10^8(\mathrm{m/s})$

5. $E=mc^2=\frac{m_0c^2}{\sqrt{1-v^2/c^2}}=5.8\times10^{-13}\ (\mathrm{J})$　　$\frac{E_{k0}}{E_k}=\frac{mv^2/2}{mc^2-m_0c^2}=8.04\times10^{-2}$

6. $E_{p重}=mgx_0=kx_0^2$　　$E_{p弹}=-\int_{x_0}^{0}k(x+x_0)\mathrm{d}x=\frac{1}{2}kx_0^2-kx_0^2=-\frac{1}{2}kx_0^2$

   $E_p=E_{p重}+E_{p弹}=\frac{1}{2}kx_0^2$

7. $\theta=\omega t=\frac{\pi}{2}+\frac{\pi}{3}=\frac{5\pi}{6}$　　$t=1$　　$\omega=\frac{5\pi}{6}$　　$T=\frac{2\pi}{\omega}=\frac{12}{5}=2.4\ (\mathrm{s})$

8. $\varphi=\varphi_{\lambda/2}+\frac{2\pi}{\lambda}\cdot\frac{\lambda}{2}=0+\pi=\pi$　　$y=A\cos(\omega t-\frac{2\pi}{\lambda}x+\pi)\ (\mathrm{SI})$

9. $\Delta\nu=\nu_{乙}-\nu_{甲}=(\frac{330+20}{330+40}-\frac{330-20}{330})\cdot500=3.3\ (\mathrm{Hz})$

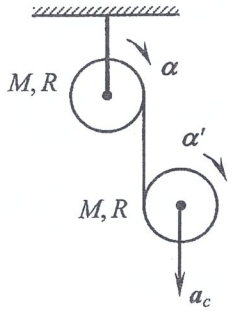
10. $\Delta T=\frac{Mv^2}{iR}=1.9\ (\mathrm{K})$　　$\Delta p=\frac{m}{M}\frac{R\Delta T}{V}=\frac{mv^2}{iV}=4\times10^4\ (\mathrm{Pa})$

11. $\overline{v}=\frac{\int_{v_1}^{v_2}vf(v)\mathrm{d}v}{\int_{v_1}^{v_2}f(v)\mathrm{d}v}$

12. $E_A=-\frac{3\sigma}{2\varepsilon_0}$　　$E_B=-\frac{\sigma}{2\varepsilon_0}$　　$E_C=\frac{\sigma}{2\varepsilon_0}$　　$E_D=\frac{3\sigma}{2\varepsilon_0}$

二、计算题：（6 题，共 52 分）

1.



$TR=\frac{1}{2}MR^2\alpha$

$Mg-T=Ma_c$　　$TR=\frac{1}{2}MR^2\alpha'$

$a_c=\alpha R+\alpha' R$

$a_c=\frac{4}{5}g$　　$\alpha=\alpha'=\frac{2g}{5R}$　　$T=\frac{1}{5}Mg$

2．（1）　$\omega' = \omega - \dfrac{v}{R/2} = \omega - \dfrac{2v}{R}$

$$[\frac{1}{2}MR^2 + \frac{M}{10}(\frac{R}{2})^2]\omega_0 = \frac{1}{2}MR^2\omega + \frac{M}{10}(\frac{R}{2})^2\omega' \qquad \omega = \omega_0 + \frac{2v}{21R}$$

（2）　$\omega = \omega_0 + \dfrac{2v}{21R} = 0 \qquad v = -\dfrac{21}{2}R\omega_0$

3．（1）　$(\dfrac{\mathrm{d}p}{\mathrm{d}V})_T = -\dfrac{p}{V} \qquad (\dfrac{\mathrm{d}p}{\mathrm{d}V})_Q = -\gamma\dfrac{p}{V} \qquad \dfrac{(\mathrm{d}p/\mathrm{d}V)_T}{(\mathrm{d}p/\mathrm{d}V)_Q} = \dfrac{-p/V}{-\gamma p/V} = \dfrac{1}{\gamma} = 0.714$

$$\gamma = \frac{1}{0.714} = 1.4 \qquad p_1V_1^\gamma = p_2V_2^\gamma \qquad p_2 = p_1(\frac{V_1}{V_2})^\gamma = 7.58\times10^4\,(\mathrm{Pa})$$

（2）　$W = \int_{V_1}^{V_2} p\mathrm{d}V = \int_{V_1}^{V_2} p_1(\dfrac{V_1}{V})^\gamma \mathrm{d}V = \dfrac{p_1V_1 - p_2V_2}{\gamma - 1} = 60.5\,(\mathrm{J})$

4．　$T_B = T_C = \dfrac{2p_0\cdot 2V_0}{\nu R} = 4T_0 \qquad V_C = \dfrac{\nu R\cdot 4T_0}{p_0} = 4V_0$

$$\Delta S_{BC} = \int_{2V_0}^{4V_0}\frac{\mathrm{d}Q_T}{T} = \nu R\ln\frac{4V_0}{2V_0} = \nu R\ln 2$$

$$\Delta S_{CA} = \int_{4T_0}^{T_0}\frac{\mathrm{d}Q_P}{T} = \nu C_P\ln\frac{T_0}{4T_0} = -\frac{5}{2}\nu R\ln 4 = -5\nu R\ln 2$$

$$\Delta S_{AB} = -(\Delta S_{BC} + \Delta S_{CA}) = 4\nu R\ln 2 \qquad \text{或：}\ \Delta S_{AB} = \nu\frac{3}{2}R\ln\frac{4T_0}{T_0} + \nu R\ln\frac{2V_0}{V_0} = 4\nu R\ln 2$$

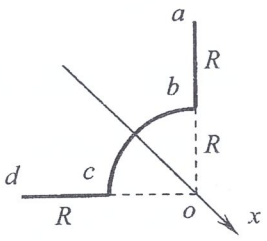
5．（1）　$A = \sqrt{2}\times10^{-2}\,(\mathrm{m}) \qquad \omega = \dfrac{2\pi}{T} = \dfrac{\pi}{2}\,(\mathrm{rad/s}) \qquad y_0(0) = \sqrt{2}\times10^{-2}\cos\varphi = \dfrac{\sqrt{2}}{2}\times10^{-2}$

$$\varphi = \cos^{-1}\frac{1}{2} = \pm\frac{\pi}{3} \qquad \varphi = \frac{\pi}{3} \qquad y_0 = \sqrt{2}\times10^{-2}\cos(\frac{\pi}{2}t + \frac{\pi}{3})\ (\mathrm{m})$$

（2）　$k = \dfrac{2\pi}{\lambda} = \dfrac{\pi}{2} \qquad y = \sqrt{2}\times10^{-2}\cos(\dfrac{\pi}{2}t - \dfrac{\pi}{2}x + \dfrac{\pi}{3})\ (\mathrm{m})$

6．　$E_{直线} = \int_R^{2R}\dfrac{\lambda\mathrm{d}x}{4\pi\varepsilon_0x^2} = \dfrac{\lambda}{8\pi\varepsilon_0R}$

$$E_{圆弧} = \int_{-\pi/4}^{\pi/4}\frac{\lambda R\mathrm{d}\theta}{4\pi\varepsilon_0R^2}\cos\theta = \frac{\sqrt{2}\lambda}{4\pi\varepsilon_0R}$$



$$E = 2E_{直线}\cos\frac{\pi}{4} + E_{圆弧} = \frac{2\lambda}{8\pi\varepsilon_0R}\cdot\frac{\sqrt{2}}{2} + \frac{\sqrt{2}\lambda}{4\pi\varepsilon_0R} = \frac{3\sqrt{2}\lambda}{8\pi\varepsilon_0R}$$

与水平方向成−45°。