试卷参考答案

二、填空题：（每题 4 分，2 个空格的题每个空格给 2 分，共 64 分）

1. $v=\dfrac{\mathrm{d}S}{\mathrm{d}t}=0.3t^2=30\ \mathrm{m/s}$，$t=10\ \mathrm{s}$；$a_t=\dfrac{\mathrm{d}v}{\mathrm{d}t}=0.6t=6\ \mathrm{m/s^2}$；$a_n=\dfrac{v^2}{R}=450\ \mathrm{m/s^2}$

2. $a=\dfrac{\mathrm{d}v}{\mathrm{d}t}=\dfrac{\mathrm{d}v}{\mathrm{d}t}\dfrac{\mathrm{d}x}{\mathrm{d}x}=v\dfrac{\mathrm{d}v}{\mathrm{d}x}=\dfrac{F}{m}=\dfrac{3+4x}{6}$；$\int_0^v v\mathrm{d}v=\int_0^3\dfrac{3+4x}{6}\mathrm{d}x$；$v=3\ \mathrm{m/s}$

3. $I=\int_0^{0.003}F\mathrm{d}t=\int_0^{0.003}(400-\dfrac{4\times10^5}{3}t)\mathrm{d}t=0.6\ \mathrm{N\cdot s}$，$m=\dfrac{I}{v}=\dfrac{0.6}{300}=2\times10^{-3}\ \mathrm{kg}=2\ \mathrm{g}$

4. $t_1'-t_2'=\dfrac{t_1-ux_1/c^2}{\sqrt{1-u^2/c^2}}-\dfrac{t_2-ux_2/c^2}{\sqrt{1-u^2/c^2}}=\dfrac{t_1-t_2-(x_1-x_2)u/c^2}{\sqrt{1-u^2/c^2}}=\dfrac{2L_0u/c^2}{\sqrt{1-u^2/c^2}}$ 或 $\dfrac{-2L_0u/c^2}{\sqrt{1-u^2/c^2}}$

5. $J_0=\dfrac{1}{3}ml^2+m(\dfrac{l}{2})^2$，$J=\dfrac{1}{3}ml^2+mx^2$，$J_0\omega_0=J\omega$，$\omega=\dfrac{7l^2\omega_0}{4(l^2+3x^2)}$

6. $E=\dfrac{m_0}{\sqrt{1-v^2/c^2}}c^2=\dfrac{5}{3}m_0c^2$，$E_k=E-m_0c^2=\dfrac{2}{3}m_0c^2$，$\dfrac{E_k}{E_0}=\dfrac{2}{3}$；$\dfrac{E_k}{E}=\dfrac{2m_0c^2/3}{5m_0c^2/3}=\dfrac{2}{5}$

7. $\Delta\varphi=\varphi_2-\varphi_1-2\pi\dfrac{r_2-r_1}{\lambda}=\dfrac{\pi}{4}-2\pi\dfrac{14-12}{16}=0$，$A=A_1+A_2=0.50\,(\mathrm{m})$

8. $y_{10}=y_{20}=2.0\times10^{-2}\cos[100\pi t-\dfrac{4\pi}{3}]$，$y_2=2.0\times10^{-2}\cos[100\pi(t-\dfrac{x}{20})-\dfrac{4\pi}{3}]\,(\mathrm{SI})$

9. $\nu_1=\dfrac{u}{u-v}\nu$，$\lambda'=\dfrac{u}{\nu_1}=\dfrac{u-v}{\nu}=\dfrac{330-15}{700}=0.45\,(\mathrm{m})$

10. $\dfrac{\bar{\varepsilon}_{tO_2}}{\bar{\varepsilon}_{tHe}}=\dfrac{3kT/2}{3kT/2}=1$；$\dfrac{E_{O_2}}{E_{He}}=\dfrac{\nu_{O_2}i_{O_2}RT/2}{\nu_{He}i_{He}RT/2}=\dfrac{m_{O_2}i_{O_2}RT/(2M_{O_2})}{m_{He}i_{He}RT/(2M_{He})}=\dfrac{M_{He}i_{O_2}}{M_{O_2}i_{He}}=\dfrac{4\times5}{32\times3}=\dfrac{5}{24}$

11. $\int_0^\infty f(v)\mathrm{d}v=1$，得 $A=\dfrac{3}{v_m^3}$，$\bar{v}=\int_0^\infty vf(v)\mathrm{d}v=\int_0^{v_m}v\dfrac{3}{v_m^3}v^2\mathrm{d}v=\dfrac{3}{4}v_m$

12. AB 段与 CD 段的电场相互抵消，圆弧段 $E=\int\mathrm{d}E_y=\int_0^\pi\dfrac{\lambda\mathrm{d}\theta}{4\pi\varepsilon_0R}\sin\theta=\dfrac{\lambda}{2\pi\varepsilon_0R}$

二、计算题：（6 题，共 52 分）

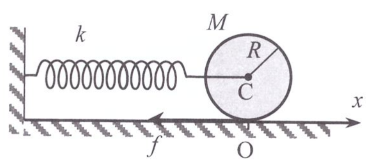
1. 解：$m_Bg-T_1=m_Ba_B$，$T_2-\mu m_Ag=m_Aa_A$，$T_1R-T_2R=J\alpha=\dfrac{1}{2}m_cR^2\alpha$，

$a_A=a_B=\alpha R$；得：$a_A=\dfrac{2(m_Bg-\mu m_Ag)}{2m_A+2m_B+m_c}$

2. 解：$-kx-f=Ma_c$，$fR=J\alpha=\dfrac{1}{2}MR^2\alpha$ 或 $-kxR=\dfrac{3}{2}MR^2\alpha$，$a_c=\alpha R$

$\dfrac{\mathrm{d}^2x}{\mathrm{d}t^2}+\dfrac{2k}{3M}x=0$，$\omega=\sqrt{\dfrac{2k}{3M}}$，$T=\dfrac{2\pi}{\omega}=2\pi\sqrt{\dfrac{3M}{2k}}$

$\because t=0$ 时，$x=x_0$，$v_0=0$ $\therefore A=x_0$，$\varphi=0$



$x=x_0\cos(\sqrt{\dfrac{2k}{3M}}t)$

3．解：$A=0.02\,(\mathrm{m})$，$x_0=-A/2$，且 $v_0<0$，故：$\varphi=\dfrac{2\pi}{3}$；

$$\Delta(\omega t+\varphi)=\omega\Delta t=2\pi-\frac{2\pi}{3}=\frac{4\pi}{3}，\quad \omega=(\frac{4\pi}{3})/\Delta t=\frac{4\pi}{3}\,(\mathrm{rad/s})$$

该质点的振动方程：$y=0.02\cos(\dfrac{4\pi}{3}t+\dfrac{2\pi}{3})\,(\mathrm{m})$

波的表达式：$y=0.02\cos(\dfrac{4\pi}{3}t-2\pi\dfrac{x-1}{3}+\dfrac{2\pi}{3})=0.02\cos(\dfrac{4\pi}{3}t-\dfrac{2\pi}{3}x+\dfrac{4\pi}{3})\,(\mathrm{m})$

4．解：$A=[\dfrac{1}{2}(1+3)\times10^5\times(3-1)\times10^{-3}]=400\ \mathrm{J}$

$$\Delta E=\nu C_V(T_b-T_a)=\frac{i}{2}(p_bV_b-p_aV_a)=1200\ \mathrm{J}$$

$$Q=A+\Delta E=1600\ \mathrm{J}$$

$$\Delta S=\nu(C_V\ln\frac{T_b}{T_a}+R\ln\frac{V_b}{V_a})=\nu(C_V\ln\frac{p_bV_b}{p_aV_a}+R\ln\frac{V_b}{V_a})=\nu(C_V\ln\frac{p_b}{p_a}+C_p\ln\frac{V_b}{V_a})$$

$$\Delta S=4R\ln 3=36.5\,(\mathrm{J/K})$$

5．解：（1）$p_0V_0^{\gamma}=\dfrac{P_0}{32}(8V_0)^{\gamma}$，$\gamma=\dfrac{5}{3}$，$i=3$

（2）$Q_{A-B}=\nu C_p(T_B-T_A)=\dfrac{i+2}{2}(p_BV_B-p_AV_A)=\dfrac{5}{2}p_0V_0$　　吸热

$Q_{C-D}=\nu C_p(T_D-T_C)=\dfrac{i+2}{2}(p_DV_D-p_CV_C)=-\dfrac{5}{8}p_0V_0$　　放热

（3）$\eta=\dfrac{A_{净}}{Q_{吸}}=1-\dfrac{Q_{放}}{Q_{吸}}=0.75$

6．解：（1）$\oiint_S\vec{E}\cdot\mathrm{d}\vec{S}=\dfrac{1}{\varepsilon_0}\sum_S q_{内}$，求 $\vec{E}$

$r\le R$，$E_1\cdot4\pi r^2=\dfrac{1}{\varepsilon_0}\sum q_{内}$，$\sum q_{内}=\iiint_V\rho\mathrm{d}V=\int_0^r kr'^2 4\pi r'^2\mathrm{d}r'=\dfrac{4}{5}\pi kr^5$，

$E_1=\dfrac{kr^3}{5\varepsilon_0}$；　　方向沿半径向外

$r\ge R$，$E_2\cdot4\pi r^2=\dfrac{1}{\varepsilon_0}\sum q_{内}$，$\sum q_{内}=\iiint_V\rho\mathrm{d}V=\int_0^R kr'^2 4\pi r'^2\mathrm{d}r'=\dfrac{4}{5}\pi kR^5$，

$E_2=\dfrac{kR^5}{5\varepsilon_0r^2}$；　方向沿半径向外

（2）$\mathrm{d}q=\lambda\mathrm{d}r$，$\mathrm{d}F=E\mathrm{d}q$，$F=\int E\mathrm{d}q=\int_{R+l}^{R+2l}\dfrac{kR^5}{5\varepsilon_0r^2}\cdot\lambda\mathrm{d}r=\dfrac{k\lambda R^5}{5\varepsilon_0}(\dfrac{1}{R+l}-\dfrac{1}{R+2l})$

方向向右