试卷参考答案

一、填空题：（12题，共48分）

1. $v=-10ti+10j$ $v=10\sqrt{t^2+1}$ $a=10(\mathrm{m/s^2})$

$a_t=\dfrac{\mathrm{d}v}{\mathrm{d}t}=\dfrac{10t}{\sqrt{t^2+1}}=5\sqrt{2}(\mathrm{m/s^2})$ $a_n=\sqrt{a^2-a_t^2}=5\sqrt{2}(\mathrm{m/s^2})$

2. $v_1=\dfrac{mv_0+M(2v-v_0)}{m+M}=2v-v_0$ $I=mv_1-mv_0=\dfrac{2mM(v-v_0)}{m+M}=2m(v-v_0)$

3. $mVR=m(v-V)R$ $V=\dfrac{v}{2}$

4. $F=\begin{cases}8t\\20\end{cases}$ $a=\begin{cases}8t/5\\4\end{cases}$ $v=\begin{cases}4t^2/5\\4t\end{cases}$ $A=\int_0^5 8t\cdot\dfrac{4}{5}t^2\mathrm{d}t+\int_5^{10}20\cdot 4t\mathrm{d}t=4000(\mathrm{J})$

5. $\lambda=1(\mathrm{m})$ 坐标原点为波腹，在 $x=2/8\mathrm{m}$ 处左右两侧反相。 $\Delta\varphi=\pi$

6. $\Delta\nu=(\dfrac{330}{330-2}-\dfrac{330}{330+2})\cdot 400\approx\dfrac{4}{330}\cdot 400=4.8(\mathrm{Hz})$

7. $y_2=A\cos(\omega t+\dfrac{2\pi x}{\lambda}-\dfrac{4\pi L}{\lambda})$

8. $pV=\nu RT$ 两气体的摩尔数相同。

$Q_{\mathrm{H}}=\Delta E=\nu\dfrac{5}{2}R\Delta T_{\mathrm{H}}=5$ $\Delta T_{\mathrm{H}}=\dfrac{2}{\nu R}$ （氢气为双原子分子，$i=5$）

$Q_{\mathrm{He}}=\nu\dfrac{3}{2}R\Delta T_{\mathrm{H}}=3(\mathrm{J})$ （氦气为单原子分子，$i=3$）

9. $pV=\dfrac{m}{M}RT$ $M=\dfrac{\rho RT}{p}$ $\sqrt{v^2}=\sqrt{\dfrac{3RT}{M}}=\sqrt{\dfrac{3p}{\rho}}=495(\mathrm{m/s})$

10. $\Delta t'=\dfrac{\Delta t}{\sqrt{1-u^2/c^2}}$ $u=c\sqrt{1-(1/2)^2}=\dfrac{\sqrt{3}}{2}c$ $\Delta x'=\dfrac{\Delta x-u\Delta t}{\sqrt{1-u^2/c^2}}=-\sqrt{3}c$

11. $m=\dfrac{m_0}{\sqrt{1-v^2/c^2}}$ $V=V_0\sqrt{1-v^2/c^2}$ $\rho=\dfrac{m}{V}=\dfrac{m_0}{V_0(1-v^2/c^2)}$

12. $\lambda=\dfrac{3.12\times10^{-9}}{2\pi\times0.5-0.02}=1\times10^{-9}(\mathrm{C/m})$ $E=\dfrac{\lambda x}{4\pi\varepsilon_0R^2}=0.72(\mathrm{V/m})$ 方向由圆心指向缝隙

二、计算题：（6题，共52分）

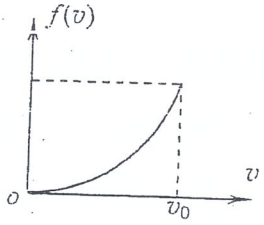
1. $F-f=ma_c$ $fR-Fr=J\alpha$ $a_c=\alpha R$ $\alpha=\dfrac{F(R-r)}{mR^2+J}=10(\mathrm{rad/s^2})$

$a_c=2.0(\mathrm{m/s^2})$ $f=17(\mathrm{N})$ $\mu\geq\dfrac{f}{mg}=0.43$

2.（1） $mv_0R=J\omega$ $J=\dfrac{1}{2}MR^2+mR^2$ $\omega=\dfrac{2mv_0}{(2m+M)R}$

（2） $M_f=\int_0^R r\cdot\mu g\cdot\sigma 2\pi r\,\mathrm{d}r=\dfrac{2}{3}\mu MgR$ $-M_f\Delta t=0-J\omega$ $\Delta t=\dfrac{3mv_0}{2\mu Mg}$

3．（1）见右图。



（2）$\int_0^{v_0} Av^2\,dv = \frac{A}{3}v_0^3 = 1$　　$A = \frac{3}{v_0^3}$

（3）$v_p = v_0$　　$\overline{v} = \int_0^{v_0} vAv^2\,dv = \frac{A}{4}v_0^4 = \frac{3}{4}v_0$

$\overline{v^2} = \int_0^{v_0} v^2 Av^2\,dv = \frac{A}{5}v_0^5 = \frac{3}{5}v_0^2$　　$\sqrt{\overline{v^2}} = \sqrt{\frac{3}{5}}v_0$

（4）$\overline{v^2} = \frac{\int_0^{v_0/2} v^2 Av^2\,dv}{\int_0^{v_0/2} Av^2\,dv} = \frac{3}{20}v_0^2$　　$\sqrt{\overline{v^2}} = \sqrt{\frac{3}{20}}v_0$

4.　$i = 5$　　$\gamma = \frac{7}{5}$　　$T_c = T_a(\frac{V_a}{V_c})^{\gamma-1} = (\frac{1}{3})^{0.4}T_a$

（1）$Q_{ab} = \nu RT_a \ln(V_b/V_a) = \nu RT_a \ln 3 = p_aV_a \ln 3$

$Q_{bc} = \nu C_V(T_c - T_b) = \frac{5}{2}\nu R(T_c - T_a) = \frac{5}{2}(p_cV_b - p_aV_a) = -\frac{5}{2}(1-3^{-0.4})p_aV_a$

$Q_{ca} = 0$　　$\eta = 1 - \frac{|Q_{bc}|}{Q_{ab}} = 0.19$

（2）$\Delta S_{bc} = \nu C_V \ln\frac{T_c}{T_b} = \frac{5}{2}\nu R\ln(\frac{1}{3})^{0.4} = -\nu R\ln 3 = -\frac{p_aV_a}{T_a}\ln 3$

或：　$\Delta S = 0$　　$\Delta S_{ca} = 0$　　$\Delta S_{bc} = -\Delta S_{ab} = -\frac{Q_{ab}}{T_a} = -\frac{p_aV_a}{T_a}\ln 3$

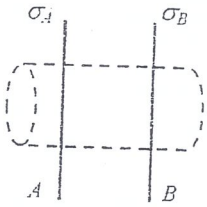
5.（1）$k = \frac{F_m}{A} = \frac{F_m}{x_m}$　　$E = \frac{1}{2}kA^2 = \frac{1}{2}F_m x_m = 0.16(J)$

（2）$v_m = A\omega$　　$\omega = \frac{v_m}{A} = \frac{v_m}{x_m} = 2\pi(\text{rad/s})$

$x_0 = 0.4\cos\varphi = 0.2$　　$\cos\varphi = \frac{1}{2}$

$v_0 = -A\omega\sin\varphi < 0$　　$\varphi = \frac{\pi}{3}$

$x = 0.4\cos(2\pi t + \frac{\pi}{3})$　(SI)



6.　$\oint E\cdot dS = \frac{1}{\varepsilon_0}\sum q$　　$E_A = \frac{|\sigma_A|}{2\varepsilon_0}$　　$E_B = \frac{\sigma_B}{2\varepsilon_0}$

$E_{中间} = E_A + E_B = \frac{|\sigma_A| + \sigma_B}{2\varepsilon_0} = 3\times10^4(\text{N/C})$　　方向向左

$E_{外侧} = E_B - E_A = \frac{\sigma_B - |\sigma_A|}{2\varepsilon_0} = 1\times10^4(\text{N/C})$　　方向向外

或：　$\int_S E_{外}\cdot dS = 2E_{外}S = \frac{\sigma_B - |\sigma_A|}{\varepsilon_0}S$

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