2020-2021 学年春夏学期《大学物理甲 1》期末考试试卷参考答案 A

一、填空题：（每题 4 分，共 48 分）

1. $\Theta=\theta\cos(\omega t+\varphi)$；$\Theta_0=\theta$；$\cos\varphi=1$；$\varphi=0$

2. $\omega=\dfrac{v_{\mathrm{m}}}{A}=3\,(\mathrm{rad/s})$，$v=-v_{\mathrm{m}}\sin(\omega t+\varphi)$，$-v_{\mathrm{m}}\sin\varphi=v_{\mathrm{m}}$，$\varphi=-\dfrac{\pi}{2}$，$x=2\times10^{-2}\cos(3t-\dfrac{\pi}{2})\,(\mathrm{SI})$

3. $\varphi_2-\varphi_1-\dfrac{2\pi}{\lambda}(r_2-r_1)=2k\pi$

4. $I=\dfrac{1}{2}\rho uA^2\omega^2=\dfrac{1}{2}\rho u(\dfrac{A_0}{2})^2\omega^2=\dfrac{1}{4}\cdot\dfrac{1}{2}\rho uA_0^2\omega^2=\dfrac{I_0}{4}$

5. $2A=0.02\ \mathrm{m}$，$A=0.01\ \mathrm{m}$，$\omega=750\,(\mathrm{rad/s})$，$\dfrac{2\pi}{\lambda}=20$，$u=\dfrac{\lambda}{T}=\dfrac{\lambda\omega}{2\pi}=\dfrac{750}{20}=37.5\ \mathrm{m/s}$

6. $\nu_1=\dfrac{u+v_R}{u}\nu=\dfrac{330+50}{330}\times900=1036\,(\mathrm{Hz})$，$\nu_2=\dfrac{u}{u-v_s}\nu_1=\dfrac{u+v_R}{u-v_s}\nu$

$$\lambda_2=\frac{u}{\nu_2}=\frac{u-v_s}{u+v_R}\cdot\frac{u}{\nu}=\frac{330-50}{330+50}\cdot\frac{330}{900}=0.27\,(\mathrm{m})$$

7. $T=\dfrac{2\varepsilon_{\mathrm{t}}}{3k}=\dfrac{2\times1.06\times10^{-19}}{3\times1.38\times10^{-23}}=5.12\times10^3\,(\mathrm{K})$

8. $\overline{v}=\sqrt{\dfrac{8RT}{\pi M}}=\sqrt{\dfrac{8R\cdot4T_0}{\pi M}}=2\overline{v}_0$，$\overline{Z}=\sqrt{2}\pi d^2n\overline{v}=\sqrt{2}\pi d^2n2\overline{v}_0=2\overline{Z}_0$，$\overline{\lambda}=\dfrac{\overline{v}}{\overline{Z}}=\dfrac{2\overline{v}_0}{2\overline{Z}_0}=\overline{\lambda}_0$；

9. $-A_p=p(V_2-V_1)=\nu R(T_2-T_1)=\nu C_p(T_2-T_1)\dfrac{R}{C_p}=\dfrac{R}{C_p}Q<Q$，$-A_V=0$，

$-A_T=\nu RT\ln\dfrac{V_2}{V_1}=Q$，故：等温

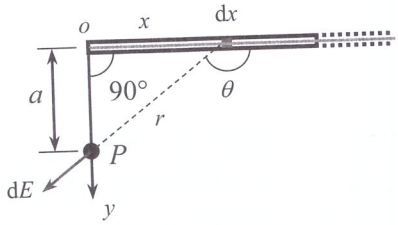
10. $e=\dfrac{Q_2}{A}=\dfrac{T_2}{T_1-T_2}$，$A=\dfrac{(T_1-T_2)}{T_2}Q_2=\dfrac{550-350}{350}\times500=285.7\,(\mathrm{J})$

11. $\Delta S=\int_{(1)}^{(2)}\dfrac{\mathrm{d}Q}{T}=\dfrac{Q_T}{T}=\nu R\ln\dfrac{V_2}{V_1}=\nu R\ln2=R\ln2$

12. $E_x=\dfrac{\lambda}{4\pi\varepsilon_0a}(\sin\pi-\sin\dfrac{\pi}{2})=-\dfrac{\lambda}{4\pi\varepsilon_0a}$

$$E_y=-\frac{\lambda}{4\pi\varepsilon_0a}(\cos\pi-\cos\frac{\pi}{2})=\frac{\lambda}{4\pi\varepsilon_0a}$$

$$E=\frac{\sqrt{2}\lambda}{4\pi\varepsilon_0a}$$



二、计算题：（6 题，共 52 分）

1. 解：$mg-T=ma=m\dfrac{\mathrm{d}^2x}{\mathrm{d}t^2}$，$TR-k(x+x_0)R=\dfrac{1}{2}MR^2\alpha$，$a=R\alpha$；平衡时：$mg=kx_0$

得：$a=-(\dfrac{2k}{2m+M})x$，$\omega=\sqrt{\dfrac{2k}{2m+M}}$，$T=\dfrac{2\pi}{\omega}=2\pi\sqrt{\dfrac{2m+M}{2k}}$

另解：$E_k=\dfrac{1}{2}mv^2+\dfrac{1}{2}J\omega^2=\dfrac{1}{2}mv^2+\dfrac{1}{2}(\dfrac{1}{2}MR^2)\dfrac{v^2}{R^2}=\dfrac{1}{2}(m+\dfrac{M}{2})v^2$，

$T=2\pi\sqrt{\dfrac{M'}{k}}=2\pi\sqrt{\dfrac{2m+M}{2k}}$

2．解：（1）$\omega=\dfrac{2\pi}{T}=\dfrac{2\pi}{4}=\dfrac{\pi}{2}\,(\text{rad/s})$，$A=4\times10^{-2}\,\text{m}$，在 $t=0$ 时有：$2=4\cos\varphi$，$v_0<0$，

故有：$\varphi=\dfrac{\pi}{3}$，o 点处质点的振动表达式　$y_o=4\times10^{-2}\cos(\dfrac{\pi}{2}t+\dfrac{\pi}{3})\,(\text{SI})$

（2）　$u=\dfrac{\lambda}{T}=\dfrac{3}{4}\,\text{m/s}$，该波的波动表达式　$y=4\times10^{-2}\cos[\dfrac{\pi}{2}(t-\dfrac{4}{3}x)+\dfrac{\pi}{3}]\,(\text{SI})$

3. 解：（1）$\int_0^{v_0}f(v)\mathrm{d}v=\int_0^{v_0}[-k(v-v_0)v]\mathrm{d}v=-\dfrac{1}{3}kv_0^3+\dfrac{1}{2}kv_0^3=1$，$\therefore\ k=\dfrac{6}{v_0^3}$

（2）$\overline{v^2}=\int_0^{v_0}v^2f(v)\mathrm{d}v=\int_0^{v_0}[-\dfrac{6}{v_0^3}(v-v_0)v^3]\mathrm{d}v=\dfrac{3}{10}v_0^2$，$\therefore\ \sqrt{\overline{v^2}}=\sqrt{\dfrac{3}{10}}v_0$

（3）$P=\int_0^{v_0/3}f(v)\mathrm{d}v=\int_0^{v_0/3}[-\dfrac{6}{v_0^3}(v-v_0)v]\mathrm{d}v=\dfrac{7}{27}=25.9\%$

4．解：$a\to b$ 是绝热过程　$Q_{ab}=0$；$b\to c$ 是等压过程：放热，$Q_{bc}=\nu C_p(T_c-T_b)$

$c\to a$ 是等体过程：吸热，$Q_{ca}=\nu C_V(T_a-T_c)$

$$\eta=1-\frac{|Q_{放}|}{Q_{吸}}=1-\frac{\nu C_p(T_b-T_c)}{\nu C_V(T_a-T_c)}=1-\gamma\frac{(T_b-T_c)}{(T_a-T_c)}$$

5．解：(1) $p_aV_a=p_bV_b$，$\therefore T_a=T_b$，　$\Delta E=0$，　$-A=\dfrac{1}{2}(p_a+p_b)(V_a-V_b)=200\,\text{J}$

$$Q=\Delta E-A=-A=200\,\text{J}$$

(2) 过程直线的方程为：$p=\dfrac{p_a-p_b}{V_a-V_b}(V-V_b)+p_b=-5\times10^7V+2\times10^5$

由：$T=\dfrac{pV}{\nu R}=\dfrac{1}{\nu R}(-5\times10^7V^2+2\times10^5V)$，

令 $\dfrac{\mathrm{d}T}{\mathrm{d}V}=0$，有：$-10\times10^7V+2\times10^5=0$，

得：$V_c=2.0\times10^{-3}\,(\text{m}^3)$，　$p_c=-5\times10^7V_c+2\times10^5=1.0\times10^5\,(\text{Pa})$

由 $\dfrac{\mathrm{d}^2T}{\mathrm{d}V^2}<0$，知此时温度最高，最高温度为 $T_c=\dfrac{p_cV_c}{\nu R}=241(K)$

6．解：$(0<r<a)$　　$\oint_S\vec{E}\cdot\mathrm{d}\vec{S}=E\cdot4\pi r^2=\dfrac{Q}{\varepsilon_0}$　　$E=\dfrac{Q}{4\pi\varepsilon_0r^2}$

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

$$E=\frac{Q+2\pi A(r^2-a^2)}{4\pi\varepsilon_0r^2}$$

$(r>b)$　　$E=\dfrac{Q+2\pi A(b^2-a^2)}{4\pi\varepsilon_0r^2}$