试 卷 答 题 纸　14061230DXWLB

课程名称：大学物理学B（上）　课程代码：PHYS120013.13

卷别：√□ A卷　□ B卷　□ C卷

姓　名：[redacted]　　学　号：[redacted]

题号	1	2	3	4	5	6	7	8	总分
得分									
题号	9	10	11	12	/	/	/	/	
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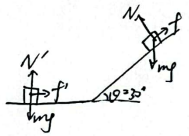
（装订线内不要答题）

1. 1) $\begin{cases} mg\sin\theta - f = ma_1 \\ mg\cos\theta = N \\ f = \mu N \end{cases}$



$\Rightarrow a_1 = g\sin\theta - \mu g\cos\theta = 4.05 m/s^2$.

$\Rightarrow v_1 = \sqrt{2a_1 L} = 5.69 m/s$.

2) $\begin{cases} f' = ma_2 \\ N' = mg \\ f' = \mu N' \end{cases}$

$\Rightarrow a_2 = \mu g = 0.98 m/s^2$.

$\Rightarrow S = \frac{v_1^2}{2a_2} = 16.5 m$.

3) 不变

2. 1) $v = \frac{dx}{dt} = 3 - 2t$　$v_0 = 3 m/s$（方向沿斜面向上）

2) $a = \frac{dv}{dt} = -2 m/s^2$（大小 $2 m/s^2$，方向沿斜面向下）

3) 当 $t < 1.5s$ 时，$v > 0$；当 $t > 1.5s$ 时，$v < 0$.

∴ 当 $t = 1.5s$ 时，物体开始下滑.

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3. 设极板宽b，间距为d，则 $C_0=\frac{\varepsilon_0 ab}{d}$.

有油时，相当于两电容器并联，$C=\frac{\varepsilon_r\varepsilon_0 hb}{d}+\frac{\varepsilon_0(a-h)b}{d}=\frac{\varepsilon_0(\varepsilon_r h+a-h)b}{d}$

∴等效相对电容率 $\frac{C}{C_0}=\frac{a+(\varepsilon_r-1)h}{a}$

4. 1) $\frac{1}{2}at^2=h \Rightarrow a=\frac{2h}{t^2}=0.2m/s^2$（a为物体加速度）

∴ $a_{切}=a=0.2m/s^2$，方向垂直指向指向盘转动方向

又 $t'=3s$ 时，物体速度 $v'=at'=0.6m/s$

∴ $a_{法}=\frac{v'^2}{R}=0.36m/s^2$，方向指向圆心.

2) $\begin{cases} TR=J\frac{a}{R} \\ mg-T=ma \end{cases}$

$\Rightarrow J=\frac{m(g-a)R^2}{a}=48\,kg\cdot m^2$.

5. 球外 $D=\frac{Q}{4\pi r^2}$ $(r>R) \Rightarrow E=\frac{D}{\varepsilon_r\varepsilon_0}=\frac{Q}{4\pi\varepsilon_r\varepsilon_0 r^2}$ $(r>R)$.

$W=\int_R^{+\infty}\frac{1}{2}DE\cdot 4\pi r^2\,dr=\int_R^{+\infty}\frac{Q^2}{8\pi\varepsilon_r\varepsilon_0 r^2}dr=\frac{Q^2}{8\pi\varepsilon_r\varepsilon_0}\cdot(-1)\cdot\left(\frac{1}{r}\right)\Big|_R^{+\infty}=\frac{Q^2}{8\pi\varepsilon_r\varepsilon_0 R}$

6. 1) 从地球看：$t_1=\frac{l}{v}=\frac{5l}{4c}$

从飞船看：$t_1'=\frac{l\sqrt{1-\beta^2}}{v}=\frac{3l}{4c}$

2) 从地球看：$t_2=t_1+\frac{l}{c}=\frac{9l}{4c}$（单看无线电传播用时为 $\frac{l}{c}$）

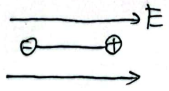
从飞船看：$t_2'=t_1'+\frac{l\sqrt{1-\beta^2}}{c}=\frac{27l}{20c}$（单看无线电传播用时为 $\frac{3l}{5c}$）

7. 电场力做功 $W_电=-W_外=-0.01J$. 电场力矩 $M=\vec{p}\times\vec{E}=|\vec{p}||\vec{E}|\cdot\sin\theta$.

又 $W_电=\int_0^{\pi}M\,d\theta=\int_0^{\pi}|\vec{p}||\vec{E}|\sin\theta\,d\theta=-|\vec{p}||\vec{E}|\cdot(-\cos\theta)\Big|_0^{\pi}=-2|\vec{p}||\vec{E}|$.

$\Rightarrow|\vec{p}||\vec{E}|=0.01N\cdot m$.

∴成45°时，$M=|\vec{p}||\vec{E}|\cdot\sin45°=7.07\times10^{-3}N\cdot m$.



课程名称：大学物理学 B（上）

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8. 1) $p_0V_0^{\gamma} = \frac{27}{8}p_0\cdot(V_{\text{左}})^{\gamma} \Rightarrow V_{\text{左}} = \frac{4}{9}V_0$，

$W = \int_{V_0}^{\frac{4}{9}V_0} -p\,dV = -\int_{V_0}^{\frac{4}{9}V_0} \frac{p_0V_0^{\gamma}}{V^{\gamma}}\,dV = p_0V_0^{1.5}\cdot\frac{1}{1-\gamma}\cdot(V^{1-\gamma})\Big|_{V_0}^{\frac{4}{9}V_0} = 2p_0V_0^{1.5}\cdot\left(\frac{1}{(\frac{4}{9}V_0)^{0.5}} - \frac{1}{V_0^{0.5}}\right) = p_0V_0$.

2) $\frac{p_0V_0}{T_0} = \frac{\frac{27}{8}p_0\cdot\frac{4}{9}V_0}{T_{\text{右}}} \Rightarrow T_{\text{右}} = \frac{3}{2}T_0$

3) $p_{\text{左}} = p_{\text{右}} = \frac{27}{8}p_0$，$V_{\text{左}} = 2V_0 - V_{\text{右}} = \frac{14}{9}V_0$

$\frac{p_0V_0}{T_0} = \frac{\frac{27}{8}p_0\cdot\frac{14}{9}V_0}{T_{\text{左}}} \Rightarrow T_{\text{左}} = \frac{21}{4}T_0$.

4) $(p_0, V_0, T_0) \to (\frac{27}{8}p_0, \frac{14}{9}V_0, \frac{21}{4}T_0)$，$C_{p,m} = \gamma C_{V,m} = 1.5C_{V,m}$.

可按分为 $(p_0, V_0, T_0) \xrightarrow{\text{等体}} (\frac{27}{8}p_0, V_0, \frac{27}{8}T_0) \xrightarrow{\text{等压}} (\frac{27}{8}p_0, \frac{14}{9}V_0, \frac{21}{4}T_0)$

$\therefore Q = V\cdot C_{V,m}\cdot(\frac{27}{8}T_0 - T_0) + V\cdot 1.5C_{V,m}\cdot(\frac{21}{4}T_0 - \frac{27}{8}T_0) = \frac{83}{16}VC_{V,m}T_0$

9. 1) 归一化条件：$1 = \int_0^{v_m} f(v)\,dv = \int_0^{v_m} Av^2\,dv = A\cdot(\frac{1}{3}v^3)\Big|_0^{v_m} = \frac{A}{3}v_m^3 \Rightarrow A = \frac{3}{v_m^3}$

2) $\bar{v} = \int_0^{v_m} v f(v)\,dv = \frac{3}{v_m^3}\int_0^{v_m} v^3\,dv = \frac{3}{v_m^3}\cdot(\frac{1}{4}v^4)\Big|_0^{v_m} = \frac{3}{4}v_m$.

3) $\sqrt{\bar{v^2}} = \sqrt{\int_0^{v_m} v^2 f(v)\,dv} = \sqrt{\frac{3}{v_m^3}\int_0^{v_m} v^4\,dv} = \sqrt{\frac{3}{v_m^3}(\frac{1}{5}v^5)\Big|_0^{v_m}} = \sqrt{\frac{3}{5}v_m^2} = \frac{\sqrt{15}}{5}v_m$

10. 1) $i = 3$，$C_{V,m} = \frac{3}{2}R$，$C_{p,m} = \frac{5}{2}R$，$T_A = T_0$，$T_B = 9T_0$，由 $q_{p_0} = p_0(\frac{V_C}{V_0})^2 \Rightarrow V_C = 3V_0 \Rightarrow T_C = 27T_0$.

$Q_{\text{I}} = 1\cdot\frac{3}{2}R\cdot(9T_0 - T_0) = 12RT_0$，$Q_{\text{II}} = 1\cdot\frac{5}{2}R\cdot(27T_0 - 9T_0) = 45RT_0$.

$Q_{\text{III}} = 1\cdot\frac{3}{2}R\cdot(T_0 - 27T_0) + \int_{3V_0}^{V_0}\frac{p_0}{V_0^2}V^2\,dV$

$= -39RT_0 + \frac{p_0}{V_0^2}(\frac{1}{3}V^3)\Big|_{3V_0}^{V_0}$

$= -39RT_0 + \frac{p_0}{V_0^2}(\frac{1}{3}V_0^3 - 9V_0^3)$

$= -\frac{143}{3}RT_0 = -47.7RT_0$.

2) $\eta = 1 - \frac{|Q_{\text{III}}|}{Q_{\text{I}} + Q_{\text{II}}} = 16.3\%$.

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11. 1) $D=\frac{Q}{S}=8.9\times10^{-5}\,C/m^2$，而 $D=\varepsilon\varepsilon_0E$

$\therefore \varepsilon_1=\frac{D}{\varepsilon_0E}=7.18$

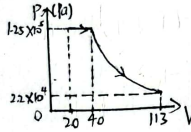
2) $\sigma'=\pm P=\pm(\varepsilon_1-1)\varepsilon_0E=7.66\times10^{-5}\,C/m^2$

$Q'=\sigma' S=\pm7.66\times10^{-7}\,C$（靠近正极板一面为负，另一面为正）

12. 1) $V_0=2\times10^{-3}m^3$，$T_0=300K$，$P_0=\frac{\nu RT_0}{V_0}=1.25\times10^5Pa$．$i=3$，$C_{V,m}=\frac{3}{2}R$，$C_{P,m}=\frac{5}{2}R$，$\gamma=\frac{5}{3}$．

$V_1=4\times10^{-3}m^3$，$T_1=600K$，$P_1=P_0=1.25\times10^5Pa$．

$V_2=\sqrt[3]{\frac{1}{2}}V_0=0.113m^3$，$T_2=300K$，$P_2=\sqrt[3]{\frac{1}{16}}P_1=2.2\times10^4Pa$．



2) $Q=1\cdot\frac{5}{2}R\cdot(T_1-T_0)=6.23\times10^3J$

3) $\Delta E=0$

4) $W=P_0V_0+1\cdot\frac{3}{2}R\cdot(T_1-T_0)=6.23\times10^3J$．