DATE 22 / 9 / 6

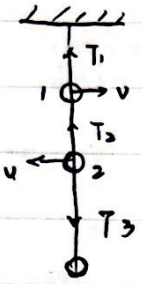
物理预赛解析

1. $^{235}_{92}U$　　α $\begin{smallmatrix}-4\\-2\end{smallmatrix}$　　β $\begin{smallmatrix}0\\+1\end{smallmatrix}$

$\therefore 235-4n=207$ ✓　　$204\sim206$ ×　　$\therefore$ $\underline{D}$

2. $\underline{BC}$ 略

3.



地系: $T_1 - mg - T_2 = ma_1$　　　$T_1 = mg + T_2 + \frac{mv^2}{R}$

$a_1 = \frac{v^2}{R}$

1系: $T_2 - mg - T_3 - ma_1 = ma_2'$　　　$T_2 = \frac{4mv^2}{R} + \frac{mv^2}{R} + mg + T_3$

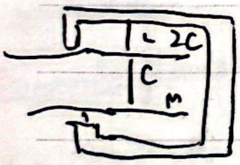
$a_2' = \frac{4v^2}{R}$

2系: $T_3 - mg - ma_2 = ma_3'$　　　$T_3 = \frac{mv^2}{R} + \frac{5mv^2}{R} + mg$

$a_3' = \frac{v^2}{R}$　　$a_2' = a_2' + a_1 = \frac{5v^2}{R}$

$\Rightarrow T_2 = 2mg + \frac{11mv^2}{L}$　　$\underline{\underline{D}}$

4. $C = \frac{\varepsilon S}{4\pi kd}$

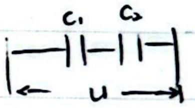


并联: $C' = C + 2C = 3C$

$\therefore \underline{\underline{C}}$

※电容串并联:

串:



$Q_1 = Q_2$

$Q = CU$　　$\therefore U_1 = \frac{C_2}{C_1+C_2}$

$\therefore \frac{U_1}{U_2} = \frac{C_2}{C_1}$　　$\therefore Q_1 = \frac{C_2C_1}{C_1+C_2}$

$= U\cdot C$

$C' = \frac{C_2C_1}{C_1+C_2}$

并:

$U_1 = U_2$

$\therefore \frac{Q_1}{Q_2} = \frac{C_1}{C_2}$　　$\therefore Q = \frac{(C_1+C_2)}{C_1}$

$= C'\cdot U$

$Q_1 = C_1U$　$\Rightarrow \underline{C' = C_1 + C_2}$

5. $I = nesv$　　$n = \frac{8.9\times10^6}{64 * N_A}$

$v = \frac{I}{nes}$　$\Rightarrow v = 0.1\,mm/s$　　$\underline{\underline{B}}$

6. $\begin{cases} mg = F_N + cv^2 \\ F = bv^2 + \mu F_N \end{cases}$　　$F_N = mg - cv^2$

$bv^2 + \mu mg - \mu cv^2 = F$　　$(b-\mu c)v^2 = F - \mu mg$

$\Rightarrow v = \sqrt{\frac{F-\mu mg}{b-\mu c}}$　　$F_N = mg - \frac{F-\mu mg}{b-\mu c}\cdot c = \frac{bmg - cF}{b-\mu c}$

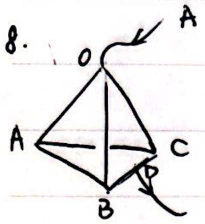
7. $T = -\frac{T_0}{3V_0^2}(V-2V_0)^2 + \frac{4}{3}T_0$

$\frac{PV}{R} = -\frac{T_0(V^2 - 4V_0V + 4V_0^2)}{3V_0^2} + \frac{4}{3}T_0 = -\frac{T_0}{3V_0^2}V^2 + \frac{4T_0}{3V_0}\cdot V$

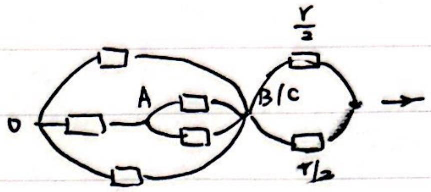
$\boxed{P = -\frac{T_0R}{3V_0^2}V + \frac{4RT_0}{3V_0}}$

$W = \int_{V_0}^{3V_0} P\,dV = \frac{4R}{3V_0}VT_0 - \frac{T_0R}{6V_0^2}V^2 \Big|_{V_0}^{3V_0} = \boxed{\frac{4}{3}RT_0}$

8.



$\rightarrow$



$\Rightarrow$ $\underline{I' = \frac{7}{8}}$

$\underline{R = \frac{5}{8} r}$

9.
$$\begin{cases} m_e w^2 r_e = \frac{ke^2}{(r_e+r_p)^2} \\ m_p w^2 r_p = \frac{ke^2}{(r_e+r_p)^2} \end{cases}$$

角动量：
$$m_e w r_e^2 + m_p w r_p^2 = n\hbar$$

$$\frac{r_e}{r_p} = \frac{m_p}{m_e}$$

$$\Rightarrow \frac{m_e m_p}{m_e+m_p} w R^2 = n\hbar \qquad w = \frac{n\hbar}{R^2} \cdot \frac{m_e+m_p}{m_e m_p}$$

$$E_n = \frac{-ke^2}{2R} = \frac{-k^2e^4(m_e m_p)}{2n^2\hbar^2(m_e+m_p)}$$

$$\frac{m_e m_p}{m_e+m_p} w^2 R = \frac{ke^2}{R^2}$$

Rydberg常量：

$$E = \left(\frac{1}{n^2} - \frac{1}{m^2}\right) \cdot R$$

$$R^3 = \frac{ke^2}{w^2} \frac{m_e+m_p}{m_e m_p} = \frac{ke^2 \cdot R^4}{n^2\hbar^2} \frac{m_e m_p}{m_e+m_p}$$

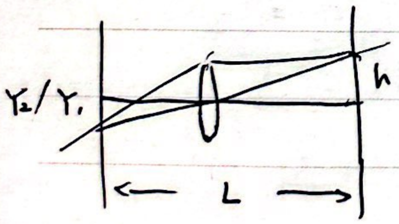
$$\Rightarrow R = E_n \cdot n^2$$

$$\Rightarrow R = \frac{n^2\hbar^2}{ke^2} \cdot \frac{m_e+m_p}{m_e m_p}$$

$$R_e : R_\mu = \frac{m_e m_p}{m_e+m_p} : \frac{m_\mu m_p}{m_\mu+m_p} = \frac{42251:227}{\cancel{206.9:1}} ??$$

$$= 186.1 : 1$$

10. $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$



$$\left(\frac{hL}{h+Y_1}\right)^{-1} + \left(\frac{Y_1 L}{h+Y_1}\right)^{-1} = \frac{1}{f}$$

$$\begin{cases} \frac{h+Y_1}{hL} + \frac{h+Y_1}{Y_1 L} = \frac{1}{f} \\ \frac{h+Y_2}{hL} + \frac{h+Y_2}{Y_2 L} = \frac{1}{f} \end{cases} \Rightarrow \underline{h = \sqrt{Y_1 Y_2}}$$

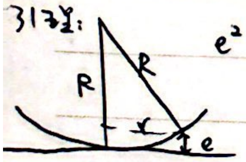
$$\frac{1}{f} = \frac{\sqrt{Y_1Y_2}+Y_1}{\sqrt{Y_1Y_2}\,L} + \frac{\sqrt{Y_1Y_2}+Y_1}{Y_1 L}$$

$$\Rightarrow \underline{f = \frac{\sqrt{Y_1Y_2}\,L}{(\sqrt{Y_1}+\sqrt{Y_2})^2}}. \qquad = \frac{(\sqrt{Y_1}+\sqrt{Y_2})^2}{\sqrt{Y_1Y_2}\,L}$$

11. 忽略二阶小量!!!

$$r^2 + (R-e)^2 = R^2$$

引理：



$$e^2 - 2Re + r^2 = 0$$

$$e = \frac{r^2}{2R}$$

(1) $\Delta e = e_1 - e_2 = \frac{r^2}{2R_1} - \frac{r^2}{2R_2}$

考虑半波损：

$$(2\Delta e) + \frac{\lambda}{2} = k\lambda$$

$$\left(\frac{1}{R_1} - \frac{1}{R_2}\right) r^2 = \left(k - \frac{1}{2}\right)\lambda$$

亮　　　　　　　　暗

$r_k=\sqrt{(k-\frac{1}{2})\lambda\frac{R_1R_2}{R_2-R_1}}$　　　$r_k=\sqrt{k\lambda\frac{R_1R_2}{R_2-R_1}}$

(2) $r_{k+m}^2-r_k^2 = m\lambda\frac{R_1R_2}{R_2-R_1}$　　　$\lambda=\frac{r_{k+m}^2-r_k^2}{m}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

(3)

$R_1, R_2>0$ 

$R_1, R_2<0$ 

$R_2\to+\infty$ 

12.

(1) $\rho g h+\rho_w g(H-h)=\rho_w g h'$

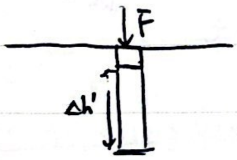
$h'=14m$

$\therefore \Delta h = h'-H=4m$

$[\rho gh+\rho_w g(H-h)+P_0]\cdot 4S=\nu RT \Rightarrow \underline{\nu\approx 3.9\times10^2 mol}$

(2) ~~∴不合理~~

~~∴Δh不变~~



$\cancel{\rho gh+\rho_w g(H-h)+P_0}$

$P'=\rho_w g(h+\Delta h')+P_0=\rho g h+\frac{F}{S}+P_0$

$P'S\cdot\Delta h'=P\cdot 4S$　　$\Rightarrow \Delta h'=\cancel{30.49m}$ $\cancel{25.97m}$ $\cancel{26.13m}$

$P'\cdot\Delta h'=9.7\times10^6$

$\frac{9.7\times10^6}{\Delta h'}=\rho_w g(h+\Delta h')+P_0$

$$\begin{cases} F+\rho g hS+P_0\cdot S=P'\cdot S \\ P'=\rho_w g(h+\Delta h')+P_0 \\ \nu RT=P'\cdot\Delta h'\cdot S \end{cases}$$

$\Rightarrow \Delta h'=5.8m$

$1.68\times10^5 N$　　$\Rightarrow F = 18000N=\underline{1.8\times10^4 N}$

13. $mg=m(\frac{2\pi}{T})^2\cdot R=\frac{GmM}{R^2}\Rightarrow GM=gR^2$　　$\Rightarrow \frac{2\pi}{T}=\frac{v}{R}$

(1) $\frac{mv^2}{(R+3.9\times10^5)}=\frac{GmM}{(R+h)^2}$　$\Rightarrow R=6.30\times10^6 m$　$\Rightarrow T=\frac{2\pi(R+h)}{v}=\cancel{5141s}\ 5.5\times10^3 s$

(2) $T'=1400s$

$\frac{7}{432}\times360°=5.83°$　　$\therefore \theta=84.2°$

No.
DATE / /

14. (1) $(3, 2.5)$

(2) $I = F_x \cdot dt = m \cdot \Delta v$ $\quad -ma_x' - \mu mg\sin\theta = ma_x$

$0-5s: \quad I_m = F_x \cdot dt = (-8cm/s^2 \cdot m - \mu mg \cdot \frac{2}{\sqrt{5}}) \cdot 5 = I = \int Ma_x' dt$

$= -2 - 20\sqrt{5}$

$\therefore I_M = -9344\ kg \cdot m/s$

$5-10s: \quad ma_x = -\mu mg\sin\theta$

$a_x = -\mu g\sin\theta$

$I_M = -\mu Mg\sin\theta t = -\cancel{1789}\ 8945\ kg \cdot m/s$

$10-15s: \Delta V = \int_{-\theta}^{+\theta} -a_x - \mu mg\sin\theta dt = 0.16m/s^2 \cdot 5s = 0.8m/s$

$I_M = M \cdot \Delta V = 800kg \cdot m/s \quad \Rightarrow \underline{I_{M总} = -17489kg \cdot m/s}$

15.

(1) $a = \frac{eE}{m} \qquad v_0\cos\theta \cdot t + \frac{eE}{2m}t^2 = h \qquad \frac{eE}{2m}t^2 + v_0\cos\theta t - h = 0$

$nd = v_0\sin\theta \cdot t$

$t = \frac{-v_0\cos\theta + \sqrt{v_0^2\cos\theta^2 + \frac{2heE}{m}}}{\frac{eE}{m}}$

$n = \frac{v_0\sin\theta}{d} \cdot \frac{m[-v_0\cos\theta + \sqrt{v_0^2\cos^2\theta + \frac{2heE}{m}}]}{eE}$

(2) $p \geq 2$

$t_1 = \frac{d}{v_0\sin\theta} \qquad h_1 = v_0\cos\theta \cdot t + \frac{eE}{2m} \cdot t^2$

$t_2 = \frac{2d}{v_0\sin\theta} \qquad h_2 = \cancel{v_0\cos\theta \cdot t} + \frac{eE}{2m} \cdot t^2$

$h = \frac{v_0\cos\theta d}{v_0\sin\theta} + \frac{eE}{2m}\frac{d^2}{v_0^2\sin^2\theta}(1 + 4^1 + 4^2 + \cdots + 4^p)$

$= \frac{d}{\tan\theta} + \frac{eEd^2}{2mv_0^2\sin^2\theta} \cdot \frac{1(1-4^p)}{-3} = \frac{4^p-1}{3}\frac{eEd^2}{2mv_0^2\sin^2\theta} + \frac{d}{\tan\theta}$

(3) $R = \frac{mv}{Bq}$

$h' = d\cot\theta$

$\sum_{i=1}^{n} \frac{mv\sin\theta}{Be} \cdot \frac{1}{2^n} = \frac{2mv\sin\theta}{Be} \qquad \therefore \underline{h_{min} = \frac{2mv\sin\theta}{Be} + d\cot\theta}$.

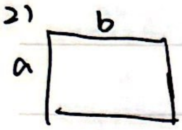
16. (1) 见9. $\quad R = \frac{n^2\hbar^2}{ke^2}\frac{m_e + m_H}{m_e m_H} \approx \frac{n^2\hbar^2}{ke^2} \cdot \frac{1}{m_e} \qquad L_n = r_n m_e v_n = n\hbar \Rightarrow v_n = \frac{ke^2}{n\hbar}$

$\Rightarrow I = \frac{ev_n}{2\pi R} = \frac{k^2e^5m_e}{2\pi n^3\hbar^3}$

(2)

No.

Date

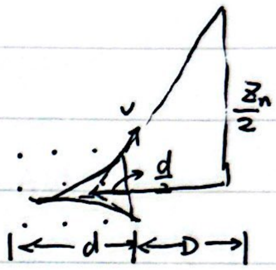
(2) 

$ab = S$

$F = b\cdot B\cdot I - B'I\cdot b = B_z\cdot a\cdot I\cdot b = \underline{B'_z\cdot I\cdot S} =$ 竖直向上

(3)

$$\begin{cases} F = B'_z I S \\ S = \pi r^2 = \dfrac{\pi \hbar^4 n^4}{m_e^2 e^4 k^2} \\ I = \dfrac{k^2 e^5 m_e}{2\pi n^3 \hbar^3} \end{cases} \Rightarrow F = \frac{n e \hbar B'_z}{2 m_e}$$



$$t = \frac{d}{v_0}$$

$$z = \frac{1}{2}\cdot\frac{F}{m_p}\cdot t^2 = \frac{n e \hbar B'_z\cdot d^2}{2\cdot 2 m_e m_H v_0^2}$$

$$\Delta Z_n = 2\cdot z = \frac{n e \hbar B'_z\cdot d^2}{2 m_e m_H v_0^2}$$

$$Z_n = 2z\cdot\frac{\frac{d}{2}+D}{\frac{d}{2}} = \underline{\frac{n e \hbar B'_z}{2 m_e m_H v_0^2}\left(D+\frac{d}{2}\right)}$$

*, 圆形证明？

$$\vec{F} = \int_0^{2\pi R} I\vec{l}\times\vec{B}\, dl$$

$$= I\int_0^{2\pi R} \vec{dl}\times\vec{B}$$

$B = B_0 + R\cos\theta\cdot B'_z$

$$= I\int_0^{2\pi} R\,d\vec{\theta}\times\vec{B}$$

x方向:

$$= IR\int_0^{2\pi} B\cdot d\theta\cdot\cos\theta$$

由几何对称性

$$= IR\int_0^{2\pi}(B_0\cos\theta + R\cos^2\theta B'_z)\,d\theta$$

$F_y = 0$

$$= IR\left(-B_0\sin\theta\Big|_0^{2\pi} + RB'_z\cdot\frac{1}{2}\cdot 2\pi\right)$$

∴ 圆形满足 $F = B'_z\cdot IS$

$$= IR\cdot R\cdot\pi\cdot B'_z = B'_z I R^2$$