第1章

附(一) 1. C

$$\frac{dv}{dt} = -kv^2 t \Rightarrow \int_{v_0}^{v} \frac{dv}{v^2} = \int_0^t -kt\,dt$$

$$\Rightarrow -\frac{1}{v}\Big|_{v_0}^{v} = -k\cdot\frac{1}{2}t^2\Big|_0^t \Rightarrow \frac{1}{v} = \frac{1}{2}kt^2 + \frac{1}{v_0}$$

2. D

$$v_x = \frac{dx}{dt} = 3 - 15t^2,\quad a_x = \frac{dv_x}{dt} = -30t < 0$$

3. A

$t=0$, $x_0=0$, $v_0=v_0$

设 t, x, v.

$$a_x = \frac{dv_x}{dt} = \frac{dv_x}{dx}\cdot\frac{dx}{dt} = v_x\frac{dv_x}{dx} = -kv_x^2$$

$$\Rightarrow \int_{v_0}^{v_x}\frac{dv_x}{v_x} = -\int_0^x k\,dx \Rightarrow \ln\left(\frac{v_x}{v_0}\right) = -kx$$

$$\Rightarrow v_x = v_0 e^{-kx}$$

(二) 1. $x_0=0$, $v_0 = 10\,m/s$.

设: $x=x$, v_x

$$a_x = \frac{dv_x}{dt} = \frac{dv_x}{dx}\cdot\frac{dx}{dt} = v_x\frac{dv_x}{dx} = 2+6x^2$$

$$\Rightarrow \int_{10}^{v_x} v_x\,dv_x = \int_0^x (2+6x^2)\,dx$$

$$\Rightarrow \frac{1}{2}v_x^2 - \frac{1}{2}\times 100 = 2x + 2x^3 \Rightarrow v_x = 2\sqrt{x+x^3+25}$$

2. $t_0=0$, $x=x_0$, $v_x=v_0$

设: t, x, v_x

1) $a_x = ct^2 \Rightarrow a_x = \frac{dv_x}{dt} = ct^2$

$$\Rightarrow \int_{v_0}^{v_x} dv_x = \int_0^t ct^2\,dt$$

$$\Rightarrow v_x = \frac{1}{3}ct^3 + v_0$$

2) $v_x = \frac{dx}{dt} = \frac{1}{3}ct^3 + v_0$

$$\Rightarrow \int_{x_0}^{x} dx = \int_0^t \left(\frac{1}{3}ct^3 + v_0\right)$$

$$\Rightarrow x = \frac{1}{12}ct^4 + v_0 t + x_0$$

第2章.

附. 1.1) $F=ma \Rightarrow a=\frac{F}{m}=5(5-2t)$

$$a_x=\frac{dv_x}{dt}=5(5-2t) \Rightarrow \int_0^{v_x} dv_x=\int_0^t 5(5-2t)\,dt$$

$$\Rightarrow v_x=25t-5t^2$$

2) $v_x=\frac{dx}{dt}=25t-5t^2 \Rightarrow \int_0^x dx=\int_0^t (25t-5t^2)\,dt$

$$\Rightarrow x=\frac{25}{2}t^2-\frac{5}{3}t^3$$

2. $t_0=0,\ x_0=0,\ v=v_0.$

设 t，x，v

1) $F=-kv=ma \Rightarrow a=-\frac{k}{m}v \Rightarrow \frac{dv}{dt}=-\frac{k}{m}v$

$$\Rightarrow \int_{v_0}^{v}\frac{dv}{v}=\int_0^t -\frac{k}{m}dt \Rightarrow \ln\frac{v}{v_0}=-\frac{k}{m}t \Rightarrow v=v_0 e^{-\frac{k}{m}t}$$

2) $v=\frac{dx}{dt}=v_0 e^{-\frac{k}{m}t} \Rightarrow \int_0^x dx=\int_0^t v_0 e^{-\frac{k}{m}t}\,dt$

$$\Rightarrow x=\frac{mv_0}{k}\left(1-e^{-\frac{k}{m}t}\right)$$

第3章.

附(一). 1. C.

水平方向动量守恒：$mv=MV$

机械能守恒：~~0+0+0=~~

$$mgR+0+0=\frac{1}{2}mv^2+\frac{1}{2}MV^2+0$$

$$m=M$$

$$\Rightarrow v=\sqrt{gR}$$

2. C. $\vec{v}=\frac{d\vec{r}}{dt}=(-A\omega\sin\omega t)\vec{i}+(B\omega\cos\omega t)\vec{j}$

$$v^2=A^2\omega^2\sin^2\omega t+B^2\omega^2\cos^2\omega t$$

$$\begin{cases} t=0,\ v_1^2=B^2\omega^2 \\ t=\frac{\pi}{2\omega},\ v_2^2=A^2\omega^2 \end{cases} \Rightarrow W=\Delta E_k=E_{k2}-E_{k1}$$

$$=\frac{1}{2}m(v_2^2-v_1^2)=\frac{1}{2}m\omega^2(A$$

(二) 1. $t_1=0 \longrightarrow t_2=3s$

$$\vec{F}=m\vec{a} \Rightarrow \vec{a}=\frac{\vec{F}}{m}=6t\vec{i} \Rightarrow a_x=\frac{dv_x}{dt}=6t$$

$$\Rightarrow \int_0^{v_x} dv_x=\int_0^{t} 6t\,dt \Rightarrow v_x=3t^2$$

$$\begin{cases} t_1=0\,,\ v_{x1}=0 \\ t_2=3s\,,\ v_{x2}=27m/s \end{cases}$$

$$W=\Delta E_k=E_{k2}-E_{k1}=\frac{1}{2}mv_{x2}^2-\frac{1}{2}mv_{x1}^2=729\,J$$

2. $\vec{r}=x\vec{i}+y\vec{j}=5t\vec{i}+\frac{1}{2}t^2\vec{j}$

$$\vec{v}=\frac{d\vec{r}}{dt}=5\vec{i}+t\vec{j}$$

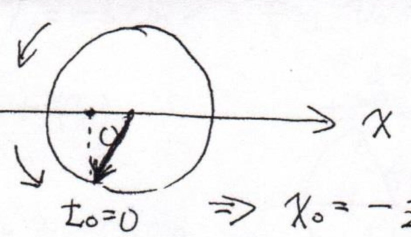
$$\begin{cases} t_1=2s\,,\ \vec{v}_1=5\vec{i}+2\vec{j} \Rightarrow v_1=\sqrt{29}\ m/s \\ t_2=4s\,,\ \vec{v}_2=5\vec{i}+4\vec{j} \Rightarrow v_2=\sqrt{41}\ m/s \end{cases}$$

$$W=\Delta E_k=E_{k2}-E_{k1}=\frac{1}{2}mv_2^2-\frac{1}{2}mv_1^2=3\,J$$

第9章.

附(一) 1. D

$t_0=0\,,\ \varphi_0=\frac{4}{3}\pi$



$\Rightarrow x_0=-\frac{A}{2}\,,\ v_0>0$

2. C.

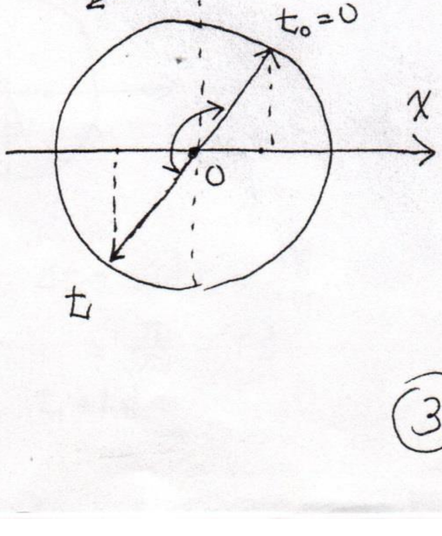
$t_0=0\,,\ x_0=+\frac{A}{2}\,,\ \varphi_0=\frac{\pi}{3}$

$t\,,\ x=-\frac{A}{2}$

$\Delta\varphi=\pi$

$$\Delta t=t-t_0=\frac{\Delta\varphi}{\omega}$$

$$\Rightarrow \Delta t=\frac{\pi}{2\pi}=\frac{1}{2}s$$

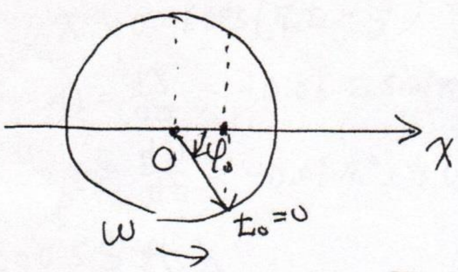


(二).

1. 1) $A=0.12m$, $T=2s$, $\omega=\frac{2\pi}{T}=\pi\ s^{-1}$

设：$x=A\cos(\omega t+\varphi_0)$

$t_0=0$时, $x_0=+0.06m=+\frac{A}{2}$, $v_0>0$



$\varphi_0=-\frac{\pi}{3}$

$x=0.12\cos(\pi t-\frac{\pi}{3})\ m$

2) $v=\frac{dx}{dt}=-0.12\pi\sin(\pi t-\frac{\pi}{3})$, $a=\frac{dv}{dt}=-0.12\pi^2\cos(\pi t-\frac{\pi}{3})$

$t=\frac{1}{4}T=\frac{1}{2}s$ 代入, $v=-0.188m/s$, $a=-1.03m/s^2$

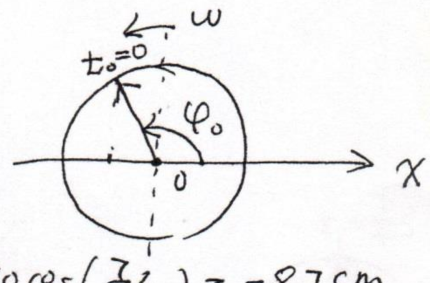
2. 已知：$A=10.0cm$, $T=2.0s \Rightarrow \omega=\frac{2\pi}{T}=\pi\ s^{-1}$

$t_0=0$时, $x_0=-5cm=-\frac{A}{2}$, $v_0<0$

1) 设：$x=A\cos(\omega t+\varphi_0)$

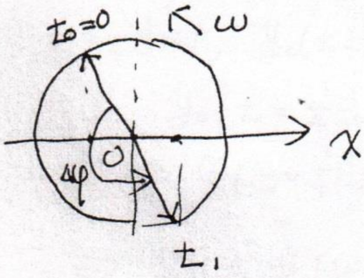
$\varphi_0=\frac{2}{3}\pi$

$x=10\cos(\pi t+\frac{2}{3}\pi)\ cm$



2) $t=0.5s$代入, $x(t=0.5s)=10\cos(\frac{7}{6}\pi)=-8.7cm$

3)

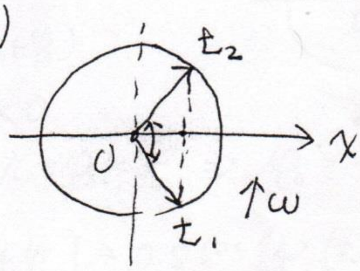


$\Delta\varphi=\pi$, $\Delta t=t_1-t_0=\frac{\Delta\varphi}{\omega}$

$=\frac{\pi}{\pi}=1s$

$t_1=1s$

4)



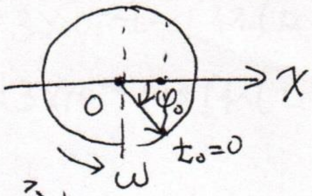
$\Delta\varphi'=\frac{2}{3}\pi$, $\Delta t=t_2-t_1$

$=\frac{\Delta\varphi'}{\omega}=\frac{2}{3}s$

3. 已知：$A=0.06m$，$T=2.0s \Rightarrow \omega=\frac{2\pi}{T}=\pi s^{-1}$

$t_0=0s$ 时，$x_0=0.03m=+\frac{A}{2}$，$v_0>0$

1) 设：$x=A\cos(\omega t+\varphi_0)$



$\varphi_0=-\frac{\pi}{3}$

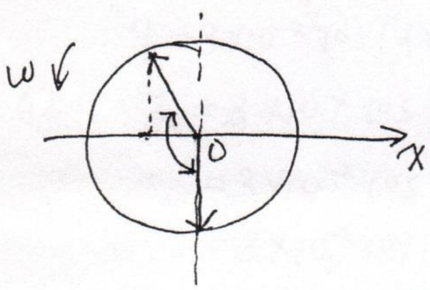
$x=0.06\cos(\pi t-\frac{\pi}{3})$

$v=\frac{dx}{dt}=-0.06\pi\sin(\pi t-\frac{\pi}{3})$

$a=\frac{dv}{dt}=-0.06\pi^2\cos(\pi t-\frac{\pi}{3})$

$t=0.5s$ 代入.

2)



$\Delta\varphi=\frac{\pi}{3}+\frac{\pi}{2}=\frac{5}{6}\pi$

$\Delta t=\frac{\Delta\varphi}{\omega}=\frac{5}{6}s$

第10章.

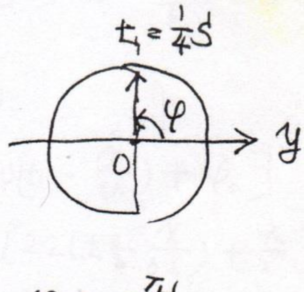
附(一) 1. A.

设：O点：$y_0=A\cos(\omega t+\varphi_0)$

$\Rightarrow y=A\cos[\omega(t-\frac{x}{u})+\varphi_0]$

已知：$A=0.5cm$，$u=8cm/s$，$\lambda=4cm$

$\Rightarrow T=\frac{\lambda}{u}=\frac{1}{2}s$，$\omega=\frac{2\pi}{T}=4\pi s^{-1}$



O点：$t=\frac{1}{4}s$ 时，$y_0(t=\frac{1}{4}s)=A\cos(\pi+\varphi_0)$

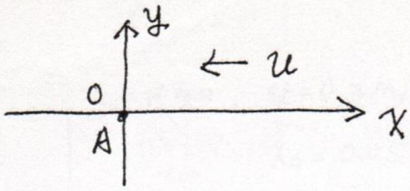
由图：$y_0(t=\frac{1}{4}s)=0$，$v_0<0$

$\Rightarrow \varphi(t=\frac{1}{4}s)=\frac{\pi}{2} \Rightarrow \pi+\varphi_0=\frac{\pi}{2} \Rightarrow \varphi_0=-\frac{\pi}{2}$

$\Rightarrow y=A\cos[\omega(t-\frac{x}{u})+\varphi_0]=0.5\cos[4\pi(t-\frac{x}{8})-\frac{\pi}{2}]$ cm

(二) 1. 已知：$u=20m/s$，A点：$y_A=3\times10^{-2}\cos(4\pi t)$

1)

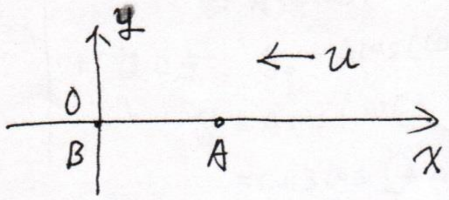


$$y_0=y_A=3\times10^{-2}\cos(4\pi t)$$

$$y=3\times10^{-2}\cos\left[4\pi\left(t+\frac{x}{u}\right)\right]$$

$$=3\times10^{-2}\cos\left[4\pi\left(t+\frac{x}{20}\right)\right]$$

2)



已知：A点：$x_A=5m$，$y_A=3\times10^{-2}\cos(4\pi t)$

设O点(B)：$y_0=A\cos(\omega t+\varphi_0)=3\times10^{-2}\cos(4\pi t+\varphi_0)$

$$y=3\times10^{-2}\cos\left[4\pi\left(t+\frac{x}{20}\right)+\varphi_0\right]$$

A点：$y_A=3\times10^{-2}\cos\left[4\pi\left(t+\frac{x_A}{20}\right)+\varphi_0\right]$

$$=3\times10^{-2}\cos\left[4\pi\left(t+\frac{5}{20}\right)+\varphi_0\right]$$

$$=3\times10^{-2}\cos(4\pi t+\underline{\pi+\varphi_0})$$

已知：$y_A=3\times10^{-2}\cos(4\pi t)$ $\Big\}\Rightarrow \pi+\varphi_0=0\Rightarrow\varphi_0=-\pi$

$$\underline{y=3\times10^{-2}\cos\left[4\pi\left(t+\frac{x}{20}\right)-\pi\right]}$$

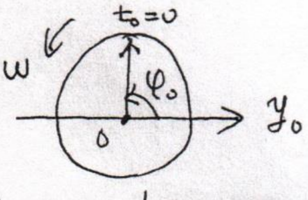
2. 2) $\frac{3}{4}\lambda=0.45\,m\Rightarrow\lambda=0.6\,m$，$\Delta t=t_2-t_1=0.25\,s$，$u=\frac{\Delta x}{\Delta t}=0.6\,m/s$

$A=0.2\,m$ $\quad\Delta x=\frac{1}{4}\lambda=0.15\,m$，

$$T=\frac{\lambda}{u}=\frac{0.6}{0.6}=1\,s\Rightarrow\omega=\frac{2\pi}{T}=2\pi\,s^{-1}$$

设：O点：$y_0=A\cos(\omega t+\varphi_0)$

$t_0=0$时，$y_0(t_0=0)=0$，$v_0(t_0=0)<0$



$$\varphi_0=+\frac{\pi}{2}$$

$$y=A\cos\left[\omega\left(t-\frac{x}{u}\right)+\varphi_0\right]$$

$$=0.2\cos\left[2\pi\left(t-\frac{x}{0.6}\right)+\frac{\pi}{2}\right]$$

1) $x_P=\frac{1}{2}\lambda=0.3m$ 代入，$y_P=0.2\cos\left[2\pi\left(t-\frac{x_P}{0.6}\right)+\frac{\pi}{2}\right]$

$$=0.2\cos\left(2\pi t-\frac{\pi}{2}\right)$$

3. 已知：$u=0.2\,m/s$，

$x_A=0.05\,m$，$y_A=0.03\cos(4\pi t-\frac{\pi}{2})\ m$

$\Rightarrow A=0.03\,m$，$\omega=4\pi\ s^{-1}$

1) 设O点：$y_0=A\cos(\omega t+\varphi_0)$

$$y=A\cos[\omega(t-\frac{x}{u})+\varphi_0]$$

$$=0.03\cos[4\pi(t-\frac{x}{0.2})+\varphi_0]$$

A点：$x_A=0.05\,m$ 代入

$$\Rightarrow y_A=0.03\cos(4\pi t\underline{-\pi+\varphi_0})$$

由 $y_A=0.03\cos(4\pi t\underline{-\frac{\pi}{2}})$

$$\Rightarrow -\pi+\varphi_0=-\frac{\pi}{2}\Rightarrow \varphi_0=\frac{\pi}{2}$$

$$\Rightarrow y=0.03\cos[4\pi(t-\frac{x}{0.2})+\frac{\pi}{2}]$$

2) $x_P=-0.05\,m$ 代入

$$y_P=0.03\cos(4\pi t+\frac{3}{2}\pi)\ m.$$

第12章

附.(一) 1. A. $p = nkT = n\frac{R}{N_0}T \Rightarrow n = \frac{PN_0}{RT}$

2. B. $p = nkT = \frac{N}{V}kT \Rightarrow N = \frac{PV}{kT}$

(二) 1. $H_2O = H_2 + \frac{1}{2}O_2$

$i = 6 \ , \ 5 \ , \ 5$

$\nu = 1mol, \ 1mol, \ \frac{1}{2}mol$

$E = \nu \cdot \frac{i}{2}RT$

$E_{H_2O} = 1 \times \frac{6}{2}RT$

$E_{H_2} = 1 \times \frac{5}{2}RT \quad \Rightarrow \Delta E = (E_{H_2} + E_{O_2}) - E_{H_2O} = \frac{3}{4}RT.$

$E_{O_2} = \frac{1}{2} \times \frac{5}{2}RT$

2. $\bar{\varepsilon}_{kO_2} = \bar{\varepsilon}_{kH_2} = 6.21 \times 10^{-21} J$

$\bar{\varepsilon}_{kO_2} = \frac{3}{2}kT \Rightarrow T = \frac{2}{3} \cdot \frac{\bar{\varepsilon}_{kO_2}}{k} = 300K.$

第13章

附(一) 1. 设 $V_1 = V_0$, $V_2 = 2V_0$, 压强不变: P

$He: \ i = 3.$

$W_1 = \int_{V_1}^{V_2} PdV = P(V_2 - V_1) = PV_0$

$Q_1 = \nu C_p(T_2 - T_1) = \nu \cdot \frac{i+2}{2}R(T_2 - T_1) = \frac{5}{2}(\nu RT_2 - \nu RT_1)$

$= \frac{5}{2}(PV_2 - PV_1)$

$= \frac{5}{2}PV_0$

$H_2: \ i = 5$

$W_2 = \int_{V_1}^{V_2} PdV = P(V_2 - V_1) = PV_0$

$Q_2 = \nu C_p(T_2 - T_1) = \nu \cdot \frac{i+2}{2}R(T_2 - T_1) = \frac{7}{2}(\nu RT_2 - \nu RT_1)$

$= \frac{7}{2}(PV_2 - PV_1) = \frac{7}{2}PV_0$

$W_1 = W_2, \ Q_1 \neq Q_2$

(二) 1. 1) $p = \frac{a^2}{V^2}$

$$W = \int_{V_1}^{V_2} p\,dV = \int_{V_1}^{V_2} \frac{a^2}{V^2} dV = a\left(\frac{1}{V_1} - \frac{1}{V_2}\right)$$

2) $PV = \nu RT$

$$\frac{T_1}{T_2} = \frac{\frac{P_1V_1}{\nu R}}{\frac{P_2V_2}{\nu R}} = \frac{P_1V_1}{P_2V_2} = \frac{\frac{a^2}{V_1^2} \cdot V_1}{\frac{a^2}{V_2^2} \cdot V_2} = \frac{V_2}{V_1}$$

3. $\nu = 1\,mol$, $T_1 = 300K$, $T_2 = 350K$

$i = 3$, $C_V = \frac{3}{2}R$, $C_p = C_V + R = \frac{5}{2}R$

$$E = \nu \cdot \frac{i}{2}RT = \frac{3}{2}RT$$

1) 等体过程:

① $Q = \nu C_V (T_2 - T_1) = 75R$

② $\Delta E = \frac{3}{2}R(T_2 - T_1) = 75R$

③ $dV = 0$, $W = 0$

2) 等压过程.

① $Q = \nu C_p (T_2 - T_1) = 125R$

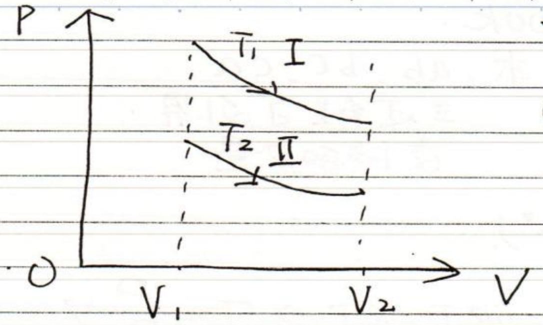
② $\Delta E = \frac{3}{2}R(T_2 - T_1) = 75R$

③ $W = \int_{V_1}^{V_2} p\,dV = P(V_2 - V_1)$

$= \nu R(T_2 - T_1) = 50R$

二.(一)2. 两个等温过程

求：哪个过程温度高？哪个过程吸热多？



$T_1 > T_2$ Ⅰ温度高.

$Q=W=\nu RT\ln(\frac{V_2}{V_1})$

$T_1 > T_2$. $Q_1 > Q_2$ Ⅰ吸热多.

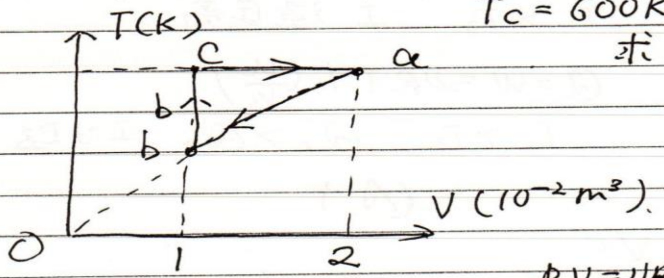
(A)

(二) 2.

1mol, 单原子分子, 进行过程如T−V图所示.

$T_c = 600K$

求：ab、bc、ca 三过程与外界交换的热量.

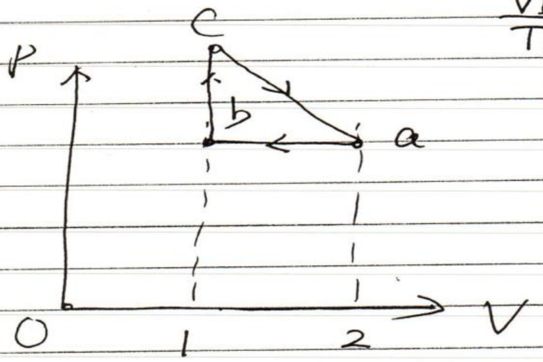


$pV=\nu RT=RT \Rightarrow T=\frac{p}{R}V$

$T_a = T_c = 600K$, 令 $T=KV$,

a→b 等压

$\frac{V_b}{T_b}=\frac{V_a}{T_a} \Rightarrow T_b=\frac{V_b}{V_a}T_a=300K$



a→b 等压.

$Q_{ab}=\nu C_p(T_b-T_a)=1\times\frac{5}{2}R\times(-300)$

$=-750R<0$

b→c 等容: $Q_{bc}=\nu C_V(T_c-T_b)$

$=1\times\frac{3}{2}R\times 300=450R>0$

c→a 等温: $Q_{ca}=W_{ca}=\nu RT_c\ln(\frac{V_a}{V_c})$

$=600R\ln 2>0$

第十四章

二. 附.

(一). 1. B. 甲(S): $x_1 = x_2$, $\Delta t = t_2 - t_1 = 4s$

乙(S'): $\Delta t' = t_2' - t_1' = \dfrac{\Delta t - v\Delta x}{\sqrt{1-\beta^2}} = \dfrac{4}{\sqrt{1-\beta^2}} = 5 \Rightarrow \beta = \dfrac{v}{c} = \dfrac{3}{5} \Rightarrow v = \dfrac{3}{5}c$

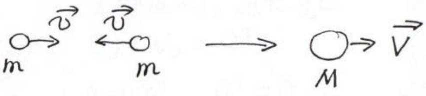
2. A. $\Delta x' = \Delta x\sqrt{1-\beta^2} \Rightarrow a' = a\sqrt{1-(\frac{4}{5})^2} = \frac{3}{5}a$

$\Delta y' = \Delta y = a$ $\Rightarrow S' = a'a = \frac{3}{5}a^2$

3. B. $E = mc^2 = Km_0c^2 \Rightarrow m = Km_0 \Rightarrow \dfrac{m_0}{\sqrt{1-\beta^2}} = km_0 \Rightarrow v = \dfrac{\sqrt{K^2-1}}{K}c$

4. B. $E_k = mc^2 - m_0c^2 = 4m_0c^2 \Rightarrow mc^2 = 5m_0c^2 \Rightarrow m = 5m_0$

5. D.



$m = \dfrac{m_0}{\sqrt{1-\beta^2}}$

动量守恒: $mv + m(-v) = MV \Rightarrow V = 0$

$\Rightarrow M = M_0$

能量守恒: $mc^2 + mc^2 = M_0c^2$

$\Rightarrow M_0 = 2m = \dfrac{2m_0}{\sqrt{1-(\frac{v}{c})^2}}$

(二)

1. $\Delta x = x_2 - x_1 = 5\times10^6 m$, $\Delta t = t_2 - t_1 = 10^{-2}s$

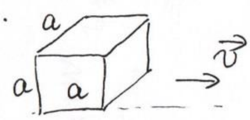
$\Delta x' = x_2' - x_1' = ?$ $\Delta t' = t_2' - t_1' = 0$

$\Delta t' = \dfrac{\Delta t - \frac{v}{c^2}\Delta x}{\sqrt{1-\beta^2}} \Rightarrow 0 = \dfrac{10^{-2} - \frac{v}{c^2}\times5\times10^6}{\sqrt{1-(\frac{v}{c})^2}}$

$\Rightarrow v = 1.8\times10^8 m/s$

$\Delta x' = \dfrac{\Delta x - v\Delta t}{\sqrt{1-(\frac{v}{c})^2}} = 4.0\times10^6 m$

2.



设静止时, 边长为a

则. $V_0 = a^3$

A观察: $a' = a\sqrt{1-(\frac{v}{c})^2}$

$V = a'\cdot a\cdot a = a^3\sqrt{1-(\frac{v}{c})^2}$

$\Rightarrow V = V_0\sqrt{1-(\frac{v}{c})^2}$

$m = \dfrac{m_0}{\sqrt{1-(\frac{v}{c})^2}}$

$\rho = \dfrac{m}{V} = \dfrac{m_0}{V_0}\cdot\dfrac{c^2}{c^2-v^2}$

3. $E_0 = m_0c^2$, $E = mc^2$, $m = \dfrac{m_0}{\sqrt{1-(\frac{v}{c})^2}}$

$E_K = E - E_0 = mc^2 - m_0c^2 = m_0c^2$

$\Rightarrow m = 2m_0$

$m = \dfrac{m_0}{\sqrt{1-(\frac{v}{c})^2}} = 2m_0 \Rightarrow v = \dfrac{\sqrt{3}}{2}c$

$p = mv = 2m_0\cdot\dfrac{\sqrt{3}}{2}c = \sqrt{3}m_0c$

第15章 量子物理

一、教材(第5版)

15-12. 已知：入射光子：$\lambda_0 = 3.0 \times 10^{-3}\ nm$

反冲电子：$v = 60\% \cdot c = \frac{3}{5}c$

求散射光子：$\lambda = ?$ $\theta = ?$

解：1) $$\left.\begin{aligned} h\nu_0 + m_0c^2 &= h\nu + mc^2 \\ m = \frac{m_0}{\sqrt{1-(\frac{v}{c})^2}} &= \frac{5}{4}m_0 \end{aligned}\right\}$$

$$\Rightarrow h\nu_0 = h\nu + \frac{1}{4}m_0c^2$$

$$\Rightarrow h\frac{c}{\lambda_0} = h\frac{c}{\lambda} + \frac{1}{4}m_0c^2 \Rightarrow \lambda = \frac{4\lambda_0 h}{4h - \lambda_0 m_0 c}$$

$$= 4.35 \times 10^{-3}\ nm$$

2). $\Delta\lambda = \lambda - \lambda_0 = \lambda_c(1-\cos\theta)$

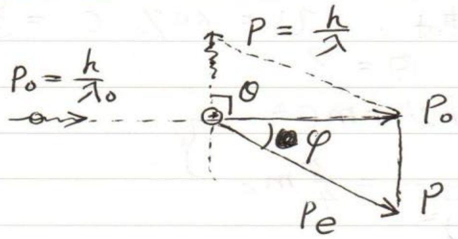
$$\cos\theta = 1 - \frac{\lambda - \lambda_0}{\lambda_c} = 0.444$$

$$\theta = 63°36'$$

15-14. 已知：$\lambda_0 = 0.10\ nm$，$\theta = 90°$

求：1) 散射光子：$\lambda = ?$

2) 反冲电子：$E_k = ?$ $\varphi = ?$



解：1). $\Delta\lambda = \lambda - \lambda_0 = \lambda_c(1-\cos\theta) = \lambda_c$

$$\lambda = \lambda_c + \lambda_0 = 0.10\ nm + 0.00243 = 0.10243\ nm$$

2) $h\nu_0 + m_0c^2 = h\nu + mc^2$

$$E_k = mc^2 - m_0c^2 = h\nu - h\nu_0 = h\frac{c}{\lambda} - h\frac{c}{\lambda_0}$$

$$\Rightarrow E_k = 4.66 \times 10^{-17}\ J$$

$$\tan\varphi = \frac{P}{P_0} = \frac{\frac{h}{\lambda}}{\frac{h}{\lambda_0}} = \frac{\lambda_0}{\lambda}$$

$$\Rightarrow \varphi = \arctan\left(\frac{\lambda_0}{\lambda}\right)$$

二. 附加(一)

1. 已知：$E_{kmax}=1.2eV$，$\lambda_0=540nm$

(D) 由：$h\nu=E_{kmax}+W=E_{kmax}+h\nu_0$

$\Rightarrow h\frac{c}{\lambda}=E_{kmax}+h\frac{c}{\lambda_0}$

$\Rightarrow \lambda=355nm$

2. $\varepsilon_0=h\nu_0=0.5MeV$，反冲电子 $E_k=0.1MeV$

由能量守恒：

(B)
$$\begin{cases} h\nu_0+m_0c^2=h\nu+mc^2 \\ E_k=mc^2-m_0c^2 \end{cases}$$

$\Rightarrow h\nu_0=h\nu+E_k \Rightarrow h\nu=0.4MeV$

$h\nu_0=h\frac{c}{\lambda_0}=0.5MeV$，$h\nu=h\frac{c}{\lambda}=0.4MeV$

$\Rightarrow \lambda_0=\frac{hc}{0.5MeV}$，$\lambda=\frac{hc}{0.4MeV}$

$$\frac{\Delta\lambda}{\lambda_0}=\frac{\lambda-\lambda_0}{\lambda_0}=\frac{\frac{hc}{0.4}-\frac{hc}{0.5}}{\frac{h}{0.5}}=\frac{1}{4}=0.25$$

(二) 计算题

1. 解：由 $T\lambda_m=b$、$M(T)=\sigma T^4$

$$\Rightarrow \frac{M(T_2)}{M(T_1)}=\frac{T_2^4}{T_1^4}=\frac{\lambda_{m1}^4}{\lambda_{m2}^4}=\left(\frac{0.69}{0.50}\right)^4=3.63$$

2、解：由：$h\nu = E_{kmax} + W$，　$\lambda\nu = c$

$$E_{kmax} = \frac{1}{2} m v_m^2 = eU_0$$

$$\nu_0 = \frac{W}{h}$$

$$\Rightarrow \begin{cases} \lambda_1 = 550nm, & h\frac{c}{\lambda_1} = eU_{01} + W \\ \lambda_2 = 190nm, & h\cdot\frac{c}{\lambda_2} = eU_{02} + W \end{cases}$$

1) $\Rightarrow U_{02} = U_{01} + \frac{hc}{e}\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right) \Rightarrow U_{02} = 4.47V$

2) $h\cdot\frac{c}{\lambda_1} = eU_{01} + W$

$\Rightarrow W = h\frac{c}{\lambda_1} - eU_{01} = 2.07eV$

3) $\nu_0 = \frac{W}{h} \Rightarrow \nu_0 = 5.0 \times 10^{14} Hz$

3、解：已知：$\lambda = 200nm$，$W = 4.2eV$

1)．由 $h\nu = E_{kmax} + W \Rightarrow h\cdot\frac{c}{\lambda} = E_{kmax} + W$

$\Rightarrow E_{kmax} = h\frac{c}{\lambda} - W = 6.21eV - 4.2eV = 2.016eV$

2) 由 $E_{kmax} = eU_0 \Rightarrow U_0 = \frac{E_{kmax}}{e} = 2.016V$

3)．$W = h\nu_0 = h\frac{c}{\lambda_0} \Rightarrow \lambda_0 = \frac{hc}{W} = 296\ nm$