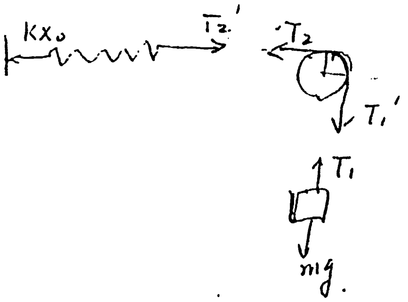
21(一)解： 普物 2001年

1. 用隔离体法



因系统静止：

$$mg - T_1 = 0 \quad \therefore T_1 = mg$$

$$T_1'R - T_2R = 0 \Rightarrow T_1' = T_2$$

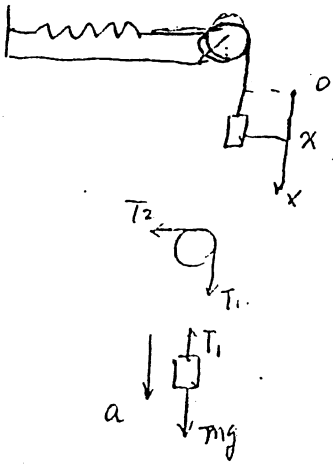
$$T_2' = kx_0$$

$$T_1' = T_1\ ,\ T_2' = T_2$$

$$x_0 = \frac{T_2'}{k} = \frac{T_2}{k} = \frac{T_1}{k} = \frac{mg}{k}$$

$$\therefore T_2 = T_1 = kx_0 = \frac{k\,mg}{k} = mg.$$

2. 设物体m处在x处



0 平衡位置

物体：$mg - T_1 = ma$ (1)

滑轮：$T_1'R - T_2R = I\beta$ (2)

弹簧：$T_2' - k(x_0+x) = 0$ (3)

~~解得~~ $T_1' = T_1,\ T_2' = T_2\quad \beta = \frac{a}{R}$

$$kx_0 = mg$$

解得：$a = -\dfrac{k}{m+\frac{I}{R^2}}x$

$$\therefore \frac{d^2x}{dt^2} + \frac{k}{m+\frac{I}{R^2}}x = 0$$

$$\therefore T = 2\pi\sqrt{\frac{m+\frac{I}{R^2}}{k}}.$$

式中 $I = \frac{1}{2}MR^2$；

2.(二)

开始时: $T_1 \sin\theta_1 = m \dfrac{v_1^2}{l_1 \sin\theta_1}$

$T_1 \cos\theta_1 = mg$

末: $T_2 \sin\theta_2 = m v_2^2 / l_2 \sin\theta_2$

$T_2 \cos\theta_2 = mg$

过程中小球所受对管轴

根据运动过程(角动量守恒

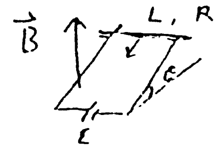
$m l_1 \sin\theta_1 v_1 = m l_2 v_2 \sin\theta_2$

分别得: $v_1 = 2.38 \ m \cdot s^{-1}$

$v_2 = 3.43 \ m \cdot s^{-1}$

再由动能定理得: $A = 0.08 \ J$

(乙型) 答物:



3. (1)

$$mg\sin\theta - ILB\cos\theta = m\frac{dv}{dt} \quad \text{——(1)}$$

$$I = \frac{\varepsilon_{感} - \varepsilon}{R} = \frac{LBv\cos\theta - \varepsilon}{R} \quad \text{——(2)}$$ 代入(1)

$$mg\sin\theta - \frac{(LB\cos\theta)^2 v}{R} + \frac{\varepsilon}{R}LB\cos\theta = m\frac{dv}{dt}$$

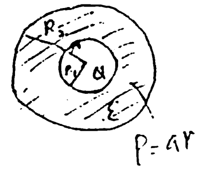
当 $\frac{dv}{dt} = 0$ 时,

$$\frac{(LB\cos\theta)^2 v_{max}}{R} = mg\sin\theta + \frac{\varepsilon}{R}LB\cos\theta$$

$$v_{max} = \frac{Rmg\sin\theta + \varepsilon LB\cos\theta}{(LB\cos\theta)^2}$$

(2)

$$P = I_{max}^2 R = \left\{\frac{LB\cos\theta}{R}\left[\frac{Rmg\sin\theta + \varepsilon LB\cos\theta}{(LB\cos\theta)^2}\right] - \frac{\varepsilon}{R}\right\}^2 R$$



4. 解.

(1) 由高斯定律: $E = 0 \quad (r < R_1)$

$$4\pi r^2 E(r) = \frac{Q + \int_{R_1}^{r} ar\,4\pi r^2\,dr}{\varepsilon} = \frac{Q + \pi a[r^4 - R_1^4]}{\varepsilon}$$

$$E(r) = \frac{Q}{4\pi\varepsilon r^2} + \frac{a[r^4 - R_1^4]}{4\varepsilon r^2} \quad (R_1 < r < R_2)$$

$$E(r) = \frac{Q}{4\pi\varepsilon_0 r^2} + \frac{a[R_2^4 - R_1^4]}{4\pi\varepsilon_0 r^2} \quad (r > R_2)$$

(2)

$$\varphi(r) = -\int_{\infty}^{r} E(r)\,dr = \frac{Q}{4\pi\varepsilon_0 r} + \frac{a[R_2^4 - R_1^4]}{4\varepsilon_0 r}$$

$(r > R_2)$

5. 解

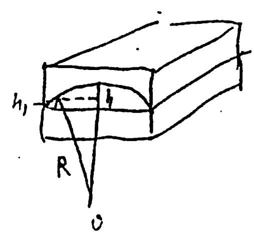
(1) $\Delta = 2h + \frac{\lambda}{2} = \frac{7}{2}\lambda + \frac{\lambda}{2} = 4\lambda$

中央为4级亮纹　　共看到7条亮纹.

(2) $2h_1 + \frac{\lambda}{2} = \lambda \Rightarrow h_1 = \frac{\lambda}{4}$

$$R^2 - x^2 = [R-(h-h_1)]^2$$

$$x = \sqrt{2R(h-h_1)-(h-h_1)^2} \approx \sqrt{3R\lambda}$$



答案：7.(理)

分析：由所给条件知，a，c 两状态位于 P-V 图上一条等温线上.

计算熵可沿该等温线积分

$$S_c - S_a = \int_a^c \frac{đQ}{T}$$

在等温线上 $đQ = dW = p\,dV$.

由于是理想气体 $PV = \nu RT \rightarrow p = \frac{\nu RT}{V}$

$$S_c - S_a = \int_a^c \frac{\nu RT}{V} dV \Big/ T = \int_a^c \nu R \frac{dV}{V} =$$

$$= \nu R \ln \frac{V_c}{V_a} = \nu R \ln 2$$

代入数值

$$S_c - S_a = 8.31 \times \ln 2 \ \ J/K$$

理)

解：

$$\frac{1}{\lambda_H} = R_H\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda_{He}} = R_{He}\left[\frac{1}{(m/Z)^2} - \frac{1}{(n/Z)^2}\right] = R_{He}\left[\frac{1}{(m/2)^2} - \frac{1}{(n/2)^2}\right]$$

$R_H \cong R_{He}$，∴ 当 $m = 4, n = 6$ 时 · $\lambda_{He} \cong \lambda_H$

由 m=1

欲使基态 He^+ 激发并发射出与氢原子 H_α 线相近的谱线，需将 He^+ 激发至 $n = 6$ 的状态。

$E_k \geq R_{He}hcZ^2(1 - 1/6^2) = 13.6 \times 4 \times 35/36 = 52.9(\text{eV})$