大学物理第七次作业

8.2 8.14 8.15 8.17 8.21

8.2

(a)

对绳上任意一点受力分析可得:

拉力 $F_T = \dfrac{y}{L}mg$

由书上柔软绳上横波模型推导出来公式:

$$v = \sqrt{\frac{F_T}{\rho}} = \sqrt{\frac{F_T}{\frac{m}{L}}}$$

$$\therefore v = \sqrt{\frac{\frac{y}{L}mg}{\frac{m}{L}}} = \sqrt{gy}$$

(b)

对于传播时间:

$$t = \int \mathrm{d}t = \int_0^L \frac{\mathrm{d}y}{v} = \int_0^L \frac{\mathrm{d}y}{\sqrt{gy}} = 2\sqrt{\frac{L}{g}}$$

(c)

由所求出来的公式可以看出, 与质量无关, 不影响.

8.14

(a)

脉动星的中心基本不振动, 所以为波节.

(b)

$\because \lambda = vT = 4R$

$\therefore T = \dfrac{4R}{v}$

(c)

$\because v^2 = r\dfrac{P}{\rho}$

$\therefore v = \sqrt{r\dfrac{P}{\rho}} \approx 1.15 \times 10^6 \mathrm{m}$

$\therefore T = \dfrac{4R}{v} \approx 22s$

8.15

(a)

设 $u(x,t) = A\cos(kx + \omega t - \varphi)$, 其中 $k = \dfrac{\omega}{v}$

对右行波 $u(x,t) = f(x - vt)$

$\therefore u(10,t) = f(10 - 80t) = 5.0\sin(1.0 - 4.0t) = 5.0\sin(0.05(10 - 80t) + 0.5)$

$\therefore u(x,t) = 5.0\sin(0.05x - 4.0t + 0.5)$

对于左行波同理有

$\therefore u(x,t) = 5.0\cos(0.05x + 4.0t + \dfrac{\pi}{2} - 1.5)$

(b)

$F_T = \rho v^2 = 0.26\ \mathrm{N}$

8.17

(a)

对于球面波:

设 $u_1(x,t) = \dfrac{A}{r_1}\cos(kr_1 - \omega t)$

$u_2(x,t) = \dfrac{A}{r_2}\cos(kr_2 - \omega t)$

$\because r_1 \approx r_2$

$\therefore$ 振幅为 $\dfrac{A}{r}, r = \dfrac{r_1 + r_2}{2}$

$\therefore u_1 + u_2 \approx \dfrac{A}{r} \cdot 2\cos k\dfrac{|r_1 - r_2|}{2} \cdot \cos(kr - \omega t)$

$\therefore$ 振幅近似为 $\dfrac{2A}{r}\cos(k\dfrac{|r_1 - r_2|}{2})$

(b)

当 $r_1 - r_2 = \dfrac{2n+1}{n}$ 时,

$\therefore \dfrac{2A}{r}\cos(\dfrac{k}{2} \cdot \dfrac{2n+1}{2}\lambda) = \dfrac{2A}{r} \cdot \cos(\dfrac{\pi}{\lambda} \cdot \dfrac{2n+1}{2}\lambda) = 0$

完全抵消.

当 $r_1 - r_2 = n\lambda$ 时,

$\dfrac{2A}{r}\cos(\dfrac{k}{2} \cdot n\lambda) = \dfrac{2A}{r} \cdot \cos(n\pi) = \pm\dfrac{2A}{r}$

完全加强.

所以不是完整双曲线.

8.21

$\because$ 形成角度为 120° 的锥面, 由折射公式可知

$\therefore \dfrac{\sin\frac{120}{2}}{\sin 90} = \dfrac{\frac{3}{4}c}{v}$

$\therefore v = \dfrac{\sqrt{3}}{2}c = 2.6 \times 10^8\ \mathrm{m/s}$