일반물리 I. Chapter. 14

17. $y = 1.3\cos(0.69x + 31t)$

(a). $A = 1.3\,cm$

(b). $y = A\cos\{k(x \pm vt)\}$. $\lambda = \frac{2\pi}{k}$

$\lambda = \frac{2\pi}{0.69}\,cm = $ 약 $9.1\,cm$

(c). $T = \frac{\lambda}{v}$, $\lambda = \frac{2\pi}{k}$

$T = \frac{2\pi}{kv} = \frac{2\pi}{31}\,s = $ 약 $0.2\,s$

(d). $kv = \omega$

$\frac{31/s}{0.69/cm} = $ 약 $45\,cm/s$

(e). 왼쪽, $-x$ 방향

21. $\frac{M}{L} = \lambda = 4100\ kg/m$, $F = 250\ MN$

$$v = \sqrt{\frac{F}{\lambda}} = \sqrt{\frac{250 \times 10^6 N}{4100\ kg/m}} = \text{약 } 247\ m/s$$

39. $f = 85\ Hz$, $v = 120\ km/h$, $u = 343\ m/s$

$$f' = f\left\{1 + (120\ km/h) / (343\ m/s)\right\}$$

$$= 85\ Hz\left\{1 + (33.34\ m/s) / (343\ m/s)\right\}$$

$$f' = \text{약 } 93\ Hz$$

61. $v = \sqrt{\frac{F}{\mu}}$, 용수철의 원래 길이를 L_0이라 하자.

$F_1 = -k(L_1 - L_0)$ 일 때 $v_1 = \sqrt{\frac{F_1}{\mu_1}}$

$F_2 = -k(2L_1 - L_0)$ 일 때 $v_2 = \sqrt{\frac{F_2}{\mu_2}} = 3v_1$

$$v_2^2 = 9v_1^2 \Rightarrow \frac{F_2}{\mu_2} = 9\frac{F_1}{\mu_1}$$

$$\mu_1 = \frac{m}{L_1}, \quad \mu_2 = \frac{m}{2L_1}$$

$$2L_1 F_2 = 9L_1 F_1 \Rightarrow 2L_1(2L_1 - L_0) = 9L_1(L_1 - L_0)$$

$$4L_1 - 2L_0 = 9L_1 - 9L_0$$

$$5L_1 = 7L_0$$

$$\boxed{L_0 = L_1\left(\frac{5}{7}\right)}$$

04. 한쪽 끝이 열린 경우, $\frac{\lambda}{4}$ 파장의 홀수배인 정지파를 형성, $L = 2.25\,m$

$$L = \frac{\lambda}{4}(2n-1) \quad (n: 1, 2, 3, \cdots)$$

$$L = \frac{\lambda}{4}\{2(n+1)-1\} = \frac{\lambda}{4}(2n+1)$$

$$f_n = \frac{v}{\lambda_n}, \quad \lambda_n = \frac{4L}{2n-1}$$

$$\therefore L = \frac{v}{4f_n}(2n-1) = \frac{v}{4f_{n+1}}(2n+1)$$

$$\frac{f_n}{f_{n+1}} = \frac{2n-1}{2n+1} \Rightarrow n = \frac{f_{n+1}+f_n}{2(f_{n+1}-f_n)}$$

(a). $f_n = 345\,Hz$, $f_{n+1} = 483\,Hz$

$$n = \frac{483\,Hz + 345\,Hz}{2(483\,Hz - 345\,Hz)} = 3$$

$\therefore f_3 = 345\,Hz$, $f_4 = 483\,Hz$.

$$\frac{f_1}{f_2} = \frac{1}{3}, \quad \frac{f_2}{f_3} = \frac{3}{5}$$

$$f_2 = 3f_1, \quad f_2 = \frac{3}{5}f_3 = \frac{3}{5}\cdot 345\,Hz.$$

$$\therefore f_1 = \frac{1}{3}f_2 = \frac{1}{5}\cdot 345\,Hz = 69\,Hz$$

(b). $v = \lambda_n f_n$

$$v = \lambda_1 f_1 = 9\,m \cdot 69\,Hz = 9\,m \cdot 69\,Hz$$

$$v = 621\,m/s$$