2300012929 于梓洋

21. (1) 设 $x = A\cos(\omega t + \varphi)$, $\varphi \in [-\frac{\pi}{2}, \frac{\pi}{2}]$

$$\therefore \begin{cases} A = 0.10 \\ \cos(\omega + \varphi) = 0 \\ \cos(\varphi) = \frac{1}{2} \end{cases} \Rightarrow \begin{cases} A = 0.10 \\ \varphi = -\frac{\pi}{3} \\ \omega = \frac{5}{6}\pi \end{cases}$$

$$\therefore x = 0.10\cos(\frac{5}{6}\pi t - \frac{\pi}{3})$$

(2) P 相位: 0.

(3) 时间 $\frac{0-(-\frac{\pi}{3})}{\frac{5}{6}\pi} = \frac{2}{5}$ (s)

22. (1) 振动同期 $2\pi\sqrt{\frac{m'}{k}} \to 2\pi\sqrt{\frac{m'+m}{k}}$

振幅. 能量 不变.

(2) 振动同期 $2\pi\sqrt{\frac{m'}{k}} \to 2\pi\sqrt{\frac{m'+m}{k}}$

平衡位: $\frac{1}{2}m'v_0^2 = \frac{1}{2}kA^2 = E_0 \Rightarrow v_0 = A\sqrt{\frac{k}{m'}}$

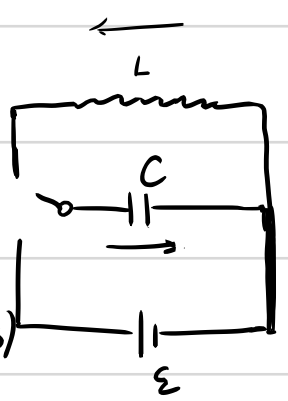
后: $(m'+m)v_1 = m'v_0 \Rightarrow v_1 = \frac{A\sqrt{km'}}{m+m'}$

$E_1 = \frac{1}{2}(m+m')v_1^2 = \frac{kA^2}{2}\frac{m'}{m+m'}$; $\frac{1}{2}kA_1^2 = E_1 \Rightarrow A_1 = A\sqrt{\frac{m'}{m+m'}}$

$\therefore$ 振幅: $A \to A\sqrt{\frac{m'}{m+m'}}$

能量: $\frac{1}{2}kA^2 \to \frac{kA^2}{2}\frac{m'}{m+m'}$

23.



(1) $\frac{d^2i}{dt^2} + \frac{i}{LC} = 0$

$\therefore i = I_0\cos(\omega t + \varphi_0)$, $\omega = \sqrt{\frac{1}{LC}} = 10^4$

$u_L = LI_0\omega\cos(\omega t + \varphi_0 + \frac{\pi}{2}) = I_0\sqrt{\frac{L}{C}}\cos(\omega t + \varphi_0 + \frac{\pi}{2})$

和 $t=0$ 时 $u_L = -\mathcal{E} = I_0\sqrt{\frac{L}{C}}\cos(\varphi_0 + \frac{\pi}{2})$

$i = 0 = I_0\cos(\varphi_0)$

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

$I_0 = 0.014$ A

L 中最大电流为 $I_0 = 0.014$ A.

(2) $E_L = \frac{1}{2}Li^2 = \frac{1}{2}LI_0^2\cos^2(\omega t+\varphi_0)$

$E_{总} = \frac{1}{2}C\mathcal{E}^2$

$E_L = E_C \Rightarrow E_L = \frac{1}{2}E_{总} \Rightarrow LI_0^2\cos^2(\omega t+\varphi_0) = \frac{1}{2}C\mathcal{E}^2$

$\Rightarrow \cos(\omega t+\varphi_0) = \pm\frac{\sqrt{2}}{2}$

$E_C = \frac{1}{2}QU_C = E_L \Rightarrow Q = \pm 0.7\sqrt{2}\times 10^{-6} \doteq \pm 9.90\times 10^{-7}$.

(3) $\cos(\omega t+\varphi_0) = \pm\frac{\sqrt{2}}{2} \Rightarrow t_{min} = \frac{\frac{\pi}{4}}{10^4} = \frac{\pi}{4\times 10^4} \doteq 7.85\times 10^{-5}$ s.

24.

(1) $\tilde{u} = U_0 e^{j(\omega t+\varphi_u)}$, $U_0 = 100$ V

$\tilde{Z} = \tilde{Z}_C + \tilde{Z}_R$.

$\frac{U_C}{U_R} = \frac{Z_C}{Z_R}$ $\quad U^2 = U_C^2 + U_R^2 \Rightarrow \begin{cases} U_C = 60\text{V} \\ U_R = 80\text{V} \end{cases}$

(2) $\tilde{I} = \frac{\tilde{u}}{\tilde{Z}} = \frac{U_0 e^{j(\omega t+\varphi_u)}}{\frac{Z_C}{j} + Z_R}$

$= \frac{U_0 e^{j(\omega t+\varphi_u)}}{\sqrt{(Z_R^2+Z_C^2)}\, e^{j\cdot\arctan\frac{Z_C}{Z_R}}}$

$= \frac{U_0}{\sqrt{Z_R^2+Z_C^2}}\, e^{j(\omega t+\varphi_u+\arctan\frac{Z_C}{Z_R})}$

∴ 电流比电压提前 $\arctan\frac{Z_C}{Z_R} = \arctan\frac{3}{4}$

$\doteq 36^\circ 52'$

25. $\tilde{Z} = R + j\omega L + \frac{j}{\omega C} = R + j(\omega L - \frac{1}{\omega C})$

$\omega_0 = \sqrt{\frac{1}{LC}} \doteq 707.107$

当 $f = \frac{\omega_0}{2\pi} \doteq 113$ Hz 时，电路谐振

$I = \frac{U}{R} \doteq 0.133$ A

$u_1 = u = u_R = IR = 220\ V$

$u_2 = u_L = I\omega_0 L = 130\ V$

$u_3 = u_C = u_L = 130\ V$

$u_4 = I\left(\omega_0 L - \frac{1}{\omega_0 C}\right) = 0\ V$

26. (1) $\omega = \frac{2\pi}{T} = \pi$

P 点: $y_P(t) = 0.1\cos(\pi t - \frac{5}{6}\pi)$

原点: $y_0(t) = 0.1\cos(\pi t + \frac{1}{3}\pi)$

(2) $y(x,t) = 0.1\cos(\pi t + \varphi_0 - kx)$

$0.2k = \pi \quad \therefore k = 5\pi \quad \therefore y(x,t) = 0.1\cos(\pi t + \varphi_0 - 5\pi x)$

$\Rightarrow y(x,t) = 0.1\cos(\pi t - 5\pi x + \frac{\pi}{3})$

27.

$P = 4\pi r^2 \rho c$

$\therefore r = 34500\ m.$

28. (1) $f_R = \frac{u}{u - v_s} f = 339.68\ Hz$

$f_R' = \frac{u}{u + v_s} f = 465.75\ Hz$

$\Delta f_R = f_R - f_R' = 73.93\ Hz$

(2) $f_R = \frac{u + v_R}{u - v_s} f = 563.49\ Hz$

29. (1) 右: $f_R = \frac{u}{u - v_s} f = 1187\ Hz$

$\lambda = \frac{u}{f_R} = 0.28\ m.$

左: $f_R = \frac{u}{u + v_s} f = 990\ Hz$

$\lambda = \frac{u}{f_R} = 0.33\ m.$

(2) $f_R' = \frac{u + v_R}{u - v_s} f = 1421\ Hz$

(3) $v = u = 331\ m/s$

(4) $f_R'' = \frac{u}{u - v_R} f_R' = 1768\ Hz$

$\lambda = \frac{1}{f_R''} = 0.187\ m$