试卷参考答案

一、填充题：（12 题，共 48 分）

1. $v = v_0 + \int_0^3 a\mathrm{d}t = 5 + \int_0^3 (3+2t)\mathrm{d}t = 23\,(\mathrm{m/s})$

2. $kx_0 = mg \qquad mg(h+x_0) = E_{k\max} + \frac{1}{2}kx_0^2 \qquad E_{k\max} = mg(h+x_0) - \frac{1}{2}kx_0^2 = mgh + \frac{m^2g^2}{2k}$

3. $mv\sin 30° = (m+M)V \qquad V = 4\,(\mathrm{m/s})$

4. $\vec{L} = \vec{r} \times m\vec{v} = 3\times 2\times 4\times \sin 150°\,\vec{k} = 12\,\vec{k}\,(\mathrm{kg\cdot m^2/s})$

   $\vec{M} = \vec{r} \times \vec{F} = 3\times 2\times \sin 30°\,\vec{k} = 3\,\vec{k}\,(\mathrm{N\cdot m})$

5. $u = v_1 \qquad \Delta x' = L \qquad \Delta t' = \frac{L}{v_2} \qquad \Delta t = \frac{\Delta t' + u\Delta x'/c^2}{\sqrt{1-v_1^2/c^2}} = \frac{L/v_2 + v_1 L/c^2}{\sqrt{1-v_1^2/c^2}}$

6. $E_k + E_0 = mc^2 = \frac{m_0c^2}{\sqrt{1-v^2/c^2}} = \frac{E_0}{\sqrt{1-v^2/c^2}} \qquad v = c\sqrt{1-(\frac{E_0}{E_k+E_0})^2} = 0.91c$

   $\tau = \frac{\tau_0}{\sqrt{1-v^2/c^2}} = \tau_0\frac{E_k+E_0}{E_0} = 5.32\times 10^{-8}(\mathrm{s})$

7. $\omega = \frac{2\pi}{T} = \frac{2\pi u}{\lambda} = \frac{\pi u}{b} \qquad \varphi_{t=t'} = -\frac{\pi}{2} \qquad y = a\cos[\frac{\pi u}{b}(t-t') - \frac{\pi}{2}]$

8. $I = \frac{P}{\pi R^2} = \frac{1}{4\pi} = 0.08\,(\mathrm{W/m^2})$

9. $v = \frac{72\times 10^3}{3600} = 20\,(\mathrm{m/s}) \qquad \nu = \frac{340+20}{340}\cdot 2 = \frac{36}{17}\,(\mathrm{Hz}) \qquad n = 60\times\nu = 127\,(\text{次})$

10. $\overline{v_x} = 0$

11. $\Delta S = \nu R\ln\frac{V_2}{V_1} = 0.5R\ln 5$

12. $\Phi_{xoy} = \vec{E}\cdot\vec{S} = 0 \qquad \Phi_{yoz} = -200b^2\,(\mathrm{N\cdot m^2/C}) \qquad \Phi_{xoz} = -300b^2\,(\mathrm{N\cdot m^2/C})$

二、计算题：（6 题，共 52 分）

1. 设重物与人所受的绳中张力分别为 T_1、T_2，系统逆时针转动。设重物的对地加速度为 a，向上。则绳的 A 端对地有加速度 a 向下，人相对于绳虽为匀速向上，但相对于地其加速度仍为 a 向下。

$$Mg - T_2 = Ma \qquad T_1 - \frac{1}{2}Mg = \frac{1}{2}Ma$$

$$T_2R - T_1R = \frac{1}{4}MR^2\beta \qquad a = \beta R$$

$$a = \frac{2}{7}g$$

2. $\frac{1}{2}(\frac{1}{3}ml^2)\omega_1^2 - mg\frac{l}{2} = 0$ $(\frac{1}{3}ml^2)\omega_2 + \frac{m}{3}vl = (\frac{1}{3}ml^2)\omega_1$

$\frac{1}{2}(\frac{1}{3}ml^2)\omega_2^2 + \frac{1}{2}(\frac{m}{3})v^2 = \frac{1}{2}(\frac{1}{3}ml^2)\omega_1^2$ $\omega_2 = 0$ $v = \sqrt{3gl}$

3. $y_0 = A\cos(\omega t + \varphi)$ $\omega = 2\pi\nu = 100\pi\ (\text{rad/s})$ $\varphi = -\frac{\pi}{2}$

$y_0 = A\cos(\omega t + \varphi) = 2\times10^{-2}\cos(100\pi t - \frac{\pi}{2})$ (SI) $\lambda = \frac{u}{\nu} = \frac{200}{50} = 4\ (\text{m})$

$y = A\cos(\omega t - \frac{2\pi}{\lambda}x + \varphi) = 2\times10^{-2}\cos(100\pi t - \frac{\pi}{2}x - \frac{\pi}{2})$ (SI)

$y_{x=4} = 2\times10^{-2}\cos(100\pi t - \frac{\pi}{2})$ (SI)

$v_{x=4,t=2} = \frac{\mathrm{d}y}{\mathrm{d}t} = 2\times10^{-2}\times100\pi\sin(100\pi\times2 - \frac{\pi}{2}) = 2\pi\ (\text{m/s})$

4.（1） $\varphi_1 = 0$ $\varphi_2 = \pm\pi$ $y_2 = A\cos[2\pi(\frac{t}{T} - \frac{x}{\lambda}) \pm \pi]$

（2） $y = y_1 + y_2 = 2A\cos(2\pi\frac{x}{\lambda} \mp \frac{\pi}{2})\cos(2\pi\frac{t}{T} \pm \frac{\pi}{2})$

（3） 波腹：$(2\pi\frac{x}{\lambda} \mp \frac{\pi}{2}) = \pm n\pi$ $n = 0,1,2,\cdots$ $x \geq 0$ $x = (n + \frac{1}{2})\frac{\lambda}{2}$ $n = 0,1,2,\cdots$

波节：$(2\pi\frac{x}{\lambda} \mp \frac{\pi}{2}) = \pm n\pi \mp \frac{\pi}{2}$ $n = 0,1,2,\cdots$ $x \geq 0$ $x = n\frac{\lambda}{2}$ $n = 0,1,2,\cdots$

5. $i = 3$ $V_c = \sqrt{\frac{p_c}{p_0}}V_0 = \sqrt{\frac{9p_0}{p_0}}V_0 = 3V_0$

$T_b = \frac{p_b}{p_a}T_a = 9T_0$ $T_c = \frac{V_c}{V_b}T_b = 27T_0$

（1） $Q_{ab} = C_V(T_b - T_a) = \frac{3}{2}R(9T_0 - T_0) = 12RT_0$

$Q_{bc} = C_p(T_c - T_b) = \frac{5}{2}R(27T_0 - 9T_0) = 45RT_0$

$Q_{ca} = C_V(T_a - T_c) + \int_{V_c}^{V_a}\frac{p_0V^2}{V_0^2}\mathrm{d}V = = \frac{3}{2}R(T_0 - 27T_0) + \frac{p_0}{3V_0^2}(V_a^3 - V_c^3) = -\frac{143}{3}RT_0$

（2） $\eta = 1 - \frac{|Q_{放}|}{Q_{吸}} = 1 - \frac{143/3}{12 + 45} = \frac{28}{171}$

6. $\mathrm{d}l = R\mathrm{d}\theta$ $\mathrm{d}q = \lambda\mathrm{d}l$ $\mathrm{d}E = \frac{\lambda\mathrm{d}l}{4\pi\varepsilon_0R^2} = \frac{\lambda\mathrm{d}\theta}{4\pi\varepsilon_0R}$

$E_x = 0$ $\mathrm{d}E_y = -\frac{\lambda\mathrm{d}\theta}{4\pi\varepsilon_0R}\cos\theta$

$E_y = 2\int\mathrm{d}E_y = -2\times2\frac{\lambda}{4\pi\varepsilon_0R}\int_0^{\pi/2}\cos\theta\mathrm{d}\theta = -\frac{\lambda}{\pi\varepsilon_0R}$