# 试卷参考答案

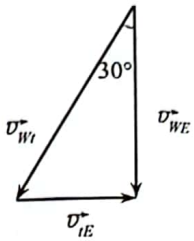
**一、填空题：**（每题 4 分，共 64 分）

1. $v=5+\int_0^3(3+2t)\mathrm{d}t=5+(3t+t^2)\big|_0^3=23(\mathrm{m/s})$

2. $v=\dfrac{\mathrm{d}s}{\mathrm{d}t}=10-t$，$a_t=\dfrac{\mathrm{d}v}{\mathrm{d}t}=-1\ \mathrm{m/s^2}$，$t=5\mathrm{s}$，$v=5\ \mathrm{m/s}$，$a_n=\dfrac{v^2}{R}=0.5\ \mathrm{m/s^2}$

$a=\sqrt{a_t^2+a_n^2}=\dfrac{\sqrt{5}}{2}\ \mathrm{m/s^2}=1.1\ \mathrm{m/s^2}$

3. 设 $W$ 雨滴，$t$ 列车，$E$ 地面，则有　$\vec{v}_{WE}=\vec{v}_{Wt}+\vec{v}_{tE}$，$v_{tE}=10\ \mathrm{m/s}$




$v_{WE}=v_{tE}\mathrm{ctg}30°=10\sqrt{3}\ \mathrm{m/s}=17.3\ \mathrm{m/s}$；　$v_{Wt}=\dfrac{v_{tE}}{\sin 30°}=20\ \mathrm{m/s}$

4. $ma\cos\theta=mg\sin\theta$　　$a=g\tan\theta$

5. $F\Delta t_1=(m_1+m_2)v_A$，$v_A=\dfrac{F\Delta t_1}{m_1+m_2}$，$F\Delta t_2=m_2(v_B-v_A)$，$v_B=\dfrac{F\Delta t_1}{m_1+m_2}+\dfrac{F\Delta t_2}{m_2}$

6. $W=\int F\mathrm{d}x=\int_0^4(6x^2+10)\mathrm{d}x=168\ (\mathrm{J})$

7. $F_x=-\dfrac{\partial E_p}{\partial x}=-2ax-by$；　$F_y=-\dfrac{\partial E_p}{\partial y}=-bx$；　$F_z=-\dfrac{\partial E_p}{\partial z}=-(-3cz^2)=3cz^2$；

$\vec{F}=-(2ax+by)\vec{i}-bx\vec{j}+3cz^2\vec{k}$

8. $mv_{\max}3R=mv_{\min}6R$，　$\dfrac{1}{2}mv_{\max}^2+(-G\dfrac{Mm}{3R})=\dfrac{1}{2}mv_{\min}^2+(-G\dfrac{Mm}{6R})$

$v_{\max}=\dfrac{2}{3}\sqrt{G\dfrac{M}{R}}=\dfrac{2}{3}\sqrt{gR}$，　$v_{\min}=\dfrac{3R}{6R}v_{\max}=\dfrac{1}{3}\sqrt{gR}$

9. $x_C=\dfrac{\int x\mathrm{d}m}{\int\mathrm{d}m}=\dfrac{\int_0^l xkx\mathrm{d}x}{\int_0^l kx\mathrm{d}x}=\dfrac{kl^3/3}{kl^2/2}=\dfrac{2}{3}l$，　$I_0=\int x^2\mathrm{d}m=\int_0^l x^2\lambda x\mathrm{d}x=\dfrac{1}{4}kl^4$

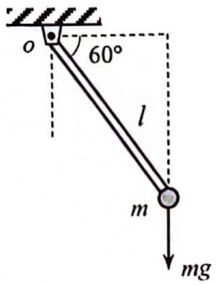
10. $M\Delta t=J\omega-J\omega_0$，　$M=\dfrac{J\omega-J\omega_0}{\Delta t}=\dfrac{0-2\pi nJ}{\Delta t}=-50\pi\ \mathrm{N\cdot m}=-157\ \mathrm{N\cdot m}$

11. 变大

12. $\int_0^\theta(-\dfrac{2}{3}m\mu gR)\mathrm{d}\theta=0-\dfrac{1}{2}J\omega_0^2$，　$\dfrac{2}{3}m\mu gR\theta=\dfrac{1}{2}\cdot\dfrac{1}{2}mR^2\omega_0^2$，　$\theta=\dfrac{3R\omega_0^2}{8\mu g}$，

$n=\dfrac{\theta}{2\pi}=\dfrac{3R\omega_0^2}{16\pi\mu g}$

13. $M_1=mgl$，　$\alpha_1=\dfrac{M_1}{I}=\dfrac{mgl}{ml^2}=\dfrac{g}{l}$，




$M_2=mgl\cos 60°=\dfrac{mgl}{2}$，　$\alpha_2=\dfrac{M_2}{J}=\dfrac{g}{2l}$

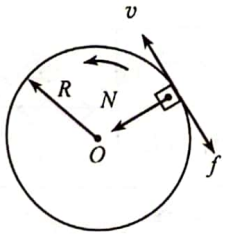
14. $x_C=\dfrac{m_1x_{10}+m_2x_{20}}{m_1+m_2}$，$\Delta x_2=x_{20}-x_2$，$\Delta x_1=x_{10}-x_1=l-\Delta x_2$；　$\Delta x_2=\dfrac{m_1}{m_1+m_2}l=1.2\ \mathrm{m}$

15： $x=x_0\sqrt{1-\frac{v^2}{c^2}}$， $y=y_0$， $z=z_0$． $V=xyz=V_0\sqrt{1-\frac{v^2}{c^2}}$ ， $m=\frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$

$$\rho=m/V=\frac{m_0/\sqrt{1-\frac{v^2}{c^2}}}{V_0\sqrt{1-\frac{v^2}{c^2}}}=\frac{m_0}{V_0(1-\frac{v^2}{c^2})}$$

16． $\Delta t'=\frac{\Delta t}{\sqrt{1-u^2/c^2}}$ $u=c\sqrt{1-(1/2)^2}=\frac{\sqrt{3}}{2}c$ $\Delta x'=\frac{\Delta x-u\Delta t}{\sqrt{1-u^2/c^2}}=-\sqrt{3}c$

## 二、计算题：（共 4 题，共 36 分）




1．解：（1） 在法向 $N=m\frac{v^2}{R}$，切向摩擦力 $f=\mu N=\mu m\frac{v^2}{R}$

（2）在切向 $-f=ma_t$， $a_t=-\frac{f}{m}=-\mu\frac{v^2}{R}$

（3） $a_t=\frac{\mathrm{d}v}{\mathrm{d}t}=-\mu\frac{v^2}{R}$， $\frac{\mathrm{d}v}{v^2}=-\frac{\mu}{R}\mathrm{d}t$， $\int_{v_0}^{v_0/3}\frac{\mathrm{d}v}{v^2}=\int_0^t-\frac{\mu}{R}\mathrm{d}t$，$\therefore\ t=\frac{2R}{\mu v_0}$

2．解： $m_Bg-T_B=m_Ba$； $T_A=m_Aa$； $(T_B-T_A)R=\frac{1}{2}m_CR^2\frac{a}{R}$；

$a=\frac{m_Bg}{m_A+m_B+m_C/2}$； $T_A=m_Aa=\frac{m_Am_Bg}{m_A+m_B+m_C/2}$

$T_B=m_Bg-m_Ba=\frac{m_Am_B+m_Bm_C/2}{m_A+m_B+m_C/2}g$

3．解： 机械能守恒： $\frac{1}{2}\cdot\frac{1}{3}Ml^2\omega^2=Mg\frac{l}{2}$，角动量守恒： $mv_0\frac{l}{2}=m\frac{v_0}{2}\cdot\frac{l}{2}+\frac{1}{3}Ml^2\omega$

$v_0=\frac{4Ml}{3m}\omega$ ； $\omega=\sqrt{\frac{3g}{l}}$ ； $v_0=\frac{4M}{3m}\sqrt{3gl}$

4．解：（1） $A=m_0c^2(\frac{1}{\sqrt{1-0.6^2}}-1)=\frac{1}{4}m_0c^2$， $m_1=\frac{m_0}{\sqrt{1-v_1^2/c^2}}=\frac{m_0}{\sqrt{1-0.6^2}}=\frac{5}{4}m_0$

（2） $\Delta p=m_0(\frac{0.8c}{\sqrt{1-0.8^2}}-\frac{0.6c}{\sqrt{1-0.6^2}})=m_0c(\frac{4}{3}-\frac{3}{4})=\frac{7}{12}m_0c$

$m_2=\frac{m_0}{\sqrt{1-v_2^2/c^2}}=\frac{m_0}{\sqrt{1-0.8^2}}=\frac{5}{3}m_0$； $E_k=m_2c^2-m_0c^2=\frac{2}{3}m_0c^2$