2020-2021 学年春夏学期《大学物理乙 1》期中考试试卷参考答案 A

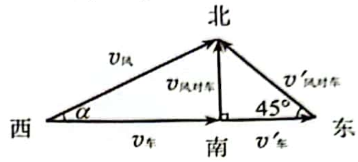
一、填空题：（每题 4 分，共 60 分）

1．$a=\dfrac{\mathrm{d}v}{\mathrm{d}t}=4-5.0t$，$t=0.50\ \mathrm{s}$，$a=4-5.0\times0.50=1.50\ \mathrm{m/s^2}$

2．$v=r\omega=rkt^2$，$k=4$，$\omega=4t^2$，$\alpha=8t$，$a_t=r\alpha=8\ (\mathrm{m/s^2})$，$a_n=r\omega^2=2\ (\mathrm{m/s^2})$

3．$v_{风对车}=v'_{车}-v_{车}=15-10=5\ \mathrm{m/s}$

$$v_{风}=\sqrt{v_{车}^2+v_{风对车}^2}=5\sqrt{5}\ \mathrm{m/s}=11.2\ \mathrm{m/s}$$



4．$mg=m\dfrac{v^2}{l-d}$；$mgl=\dfrac{1}{2}mv^2+mg\cdot2(l-d)$；得 $d=\dfrac{3}{5}l=0.6l$.

5．沿斜面方向动量守恒：$Mv_0=mv\cos\theta$，$v=\dfrac{Mv_0}{m\cos\theta}$

6．$W=\int_1^2 5t\,\vec{i}\bullet(\mathrm{d}t\,\vec{i}+2t\mathrm{d}t\,\vec{j})=\int_1^2 5t\mathrm{d}t=\dfrac{5}{2}(2^2-1^2)=\dfrac{15}{2}\ \mathrm{J}$

7．$x=x_2$；u_0

8．取地面为势能零点，$U_1=\int_{3R}^{R}-G\dfrac{Mm}{r^2}\mathrm{d}r=G\dfrac{Mm}{R}-G\dfrac{Mm}{3R}=\dfrac{2GMm}{3R}$

9．地心 O 为坐标原点，$x_C=\dfrac{M\cdot0+ml}{M+m}\approx4.72\times10^3\ (\mathrm{km})$

10．$J=\int r^2\mathrm{d}m$，变小；$E_k=\dfrac{1}{2}J\omega^2=\dfrac{1}{2}J_0\omega_0\omega$，变大.

11．$J=\dfrac{1}{3}m_1(\dfrac{L}{2})^2+\dfrac{1}{12}m_2(\dfrac{L}{2})^2+m_2(\dfrac{3}{4}L)^2=\dfrac{1}{12}m_1L^2+\dfrac{7}{12}m_2L^2$

12．$J_1\omega_0=(J_1+J_2)\omega=(J_1+2J_1)\omega=3J_1$；$\omega=\dfrac{\omega_0}{3}$

13．$l=l_0\sqrt{1-\dfrac{v^2}{c^2}}=10\sqrt{1-(\dfrac{1.8\times10^8}{3\times10^8})^2}=8\ (\mathrm{m})$

14．$\dfrac{m_0v}{\sqrt{1-v^2/c^2}}=2m_0v$，$v=\dfrac{\sqrt{3}}{2}c$；$\dfrac{m_0c^2}{\sqrt{1-v^2/c^2}}-m_0c^2=m_0c^2$，$v=\dfrac{\sqrt{3}}{2}c$

15．$\Delta t'=\dfrac{\Delta t-v\Delta x/c^2}{\sqrt{1-v^2/c^2}}$，$\Delta t'=0$，$v=-c/2=-1.5\times10^8\ \mathrm{m/s}$；$\Delta x'=\dfrac{\Delta x-v\Delta t}{\sqrt{1-v^2/c^2}}=3\sqrt{3}\times10^4\ \mathrm{m}$

二、计算题：（共 4 题，共 40 分）

1、解：$F=F_0-kx$，　$k=\dfrac{F_0}{L}$，　$F=F_0(1-\dfrac{x}{L})$

解法一：$W=\int_0^L \vec{F}\bullet d\vec{x}=\int_0^L F_0(1-\dfrac{x}{L})dx=\dfrac{F_0L}{2}=\dfrac{1}{2}mv^2-\dfrac{1}{2}mv_0^2$，$v=\sqrt{\dfrac{F_0L}{m}}$

解法二：$a=\dfrac{F}{m}=\dfrac{F_0}{m}(1-\dfrac{x}{L})=\dfrac{dv}{dt}=v\dfrac{dv}{dx}$，$\int_0^v vdv=\int_0^L\dfrac{F_0}{m}(1-\dfrac{x}{L})dx$，$v=\sqrt{\dfrac{F_0L}{m}}$

2．解：对 B 点的角动量守恒：$mv_0D=mvd$，得：$v=\dfrac{D}{d}v_0$

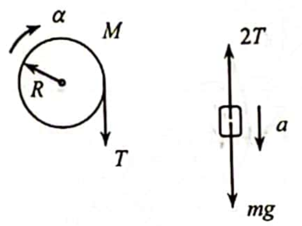
两质点系统机械能守恒：$\dfrac{1}{2}mv_0^2+0=\dfrac{1}{2}mv^2+(-G\dfrac{Mm}{d})$，$M=\dfrac{D^2-d^2}{2Gd}v_0^2$

3．解：$mg-2T=ma$

$TR=\dfrac{1}{2}MR^2\alpha$

$\alpha R=2a$

得：$a=\dfrac{m}{2M+m}g$



4．解：（1）解法一：细杆质心位置：$r_C=\dfrac{(-l/2)(M/3)+l(2M/3)}{M}=\dfrac{l}{2}$

竖直位置时，质心与初始位置的高度：$\Delta h_C=\dfrac{l}{2}+\dfrac{l}{2}\sin 30°=\dfrac{3}{4}l$

细杆转动惯量：$J=\dfrac{1}{12}M(3l)^2+M(\dfrac{l}{2})^2=Ml^2$

碰前细杆受重力矩作用而转动，根据转动动能定理有：

$$\frac{1}{2}J\omega_0^2=Mgh_C=\frac{3}{4}Mgl，\quad \omega_0=\sqrt{\frac{3g}{2l}}$$

解法二：碰前细杆受重力矩做功而转动，根据转动动能定理有：

$$\frac{1}{2}J\omega_0^2=\int_{-30°}^{90°}Mg\frac{l}{2}\cos\theta d\theta=\frac{3}{4}Mgl$$

将转动惯量 $J=\int_{-l}^{2l}\dfrac{M}{3l}x^2dx=Ml^2$ 代入上式，得：$\omega_0=\sqrt{\dfrac{3g}{2l}}$

（2）对细杆与小球组成的系统，碰撞过程角动量守恒

$$J\omega_0=(J+ml^2)\omega$$

解得：$\omega=\dfrac{J\omega_0}{(J+ml^2)}=\dfrac{M}{(M+m)}\sqrt{\dfrac{3g}{2l}}$