AP Physics C Test 1 Corrections

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2.

Constant acceleration means that we can solve this using the following equation:

$$\begin{aligned} \theta_f &= \frac{1}{2}\alpha t^2 \\ 16 \cdot 2\pi &= \frac{1}{2}\alpha (10)^2 \\ \frac{32\pi \cdot 2}{100} &= \alpha \\ \alpha &= \frac{16\pi}{25}\,\mathrm{s}^{-2} \end{aligned}$$

Then we can use the following equation for ω_f:

$$\begin{aligned} \alpha t &= \omega_f \\ \frac{16\pi}{25} \cdot 10 &= \omega_f \\ \omega_f &= \frac{32\pi}{5}\,\mathrm{s}^{-1} \end{aligned}$$

4.

First calculate moment of inertia:

$$\begin{aligned} I &= I_{\text{thin rod}} + I_{\text{displacement}} \\ &= \frac{1}{12}ML^2 + Md^2 \\ &= \frac{1}{12}ML^2 + \frac{1}{16}ML^2 \\ &= \frac{7}{48}ML^2 \end{aligned}$$

Then we use the following equations for torque to solve for α:

$$\begin{aligned} I\alpha &= \tau_{\text{net}} \\ &= Mg \cdot \frac{L}{4} \cdot \sin(150) \\ \alpha &= \frac{MgL}{8I} \\ &= \frac{6g}{7L} \end{aligned}$$

5.

a) Calculate the mechanical energy for both carts and compare it to cart B.

$$\begin{aligned} ME_A &= \frac{1}{2}Mv^2 + MR^2\omega^2 = \frac{3}{2}Mv^2 \\ &= 2Mgh \\ gh_A &= \frac{3}{4}v^2 \\ ME_B &= \frac{3}{2}Mv^2 \\ &= 3Mgh \\ gh_B &= \frac{1}{2}v^2 \\ \frac{gh_B}{gh_A} &= \frac{2}{3} \end{aligned}$$

Thus, $h_B = \frac{2}{3}h$.

b) Friction must slow the rotation of the wheel, so it points up the ramp. Friction also is the only thing causing torque, so we can find α that way. Then we can just use equations for net torque and net force.

$$\begin{aligned} \tau_{\text{net}} &= MR^2\alpha = F_f R \\ \alpha &= \frac{F_f}{MR} \\ a &= \frac{F_f}{M} \\ F_{\text{net}} &= 2Ma = 2Mg \cdot \sin(\theta) - F_f \\ 3F_f &= 2Mg \cdot \sin(\theta) \\ F_f &= \frac{2}{3}Mg \cdot \sin(\theta) \end{aligned}$$