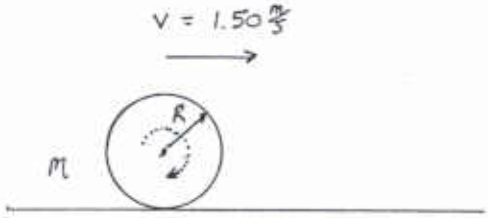
Units? Units?

Name_____

# Phys 121
## Quiz #4 — Spring 2001




**1.** A uniform cylinder with a radius of 0.200 m and a mass of 0.300 kg rolls without slipping on a horizontal surface such that speed of its center is $1.50\frac{m}{s}$.

R or = 0.200 m
m R = 0.300 kg

**a)** What is the moment of inertia of the cylinder. (Recall, cylinder≡ disk!)

$I_{cyl} = \frac{1}{2} m R^2 = \frac{1}{2}(0.300\,kg)(0.200\,m)^2$

$= \boxed{6.00 \times 10^{-3}\ kg \cdot m^2}$

**b)** What is the angular velocity of the cylinder?

$V_{cm} = \omega R$

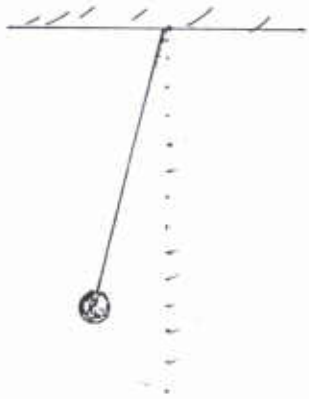
$\rightarrow \omega = \frac{V_{cm}}{R} = \frac{(1.50\,m/s)}{(0.200\,m)} = \boxed{7.50\ \frac{rad}{s}}$

**c)** What is the total kinetic energy of the cylinder?

$KE_{tot} = KE_{roll} = KE_{trans} + KE_{rot} = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2}(0.300\,kg)(1.50\,m/s)^2 + \frac{1}{2}(6.00 \times 10^{-3}\,kg \cdot m^2)(7.50\,rad/s)^2$

$= \boxed{0.506\ J}$



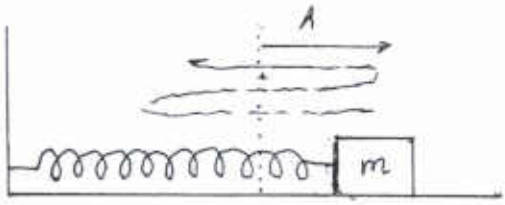
**2.** What is the length of a simple pendulum which makes small oscillations with a period of 3.0 s?

$T = 2\pi\sqrt{\frac{l}{g}} \rightarrow T^2 = 4\pi^2 \frac{l}{g}$

$\rightarrow l = \frac{T^2 g}{4\pi^2} = \frac{1}{4\pi^2}(3.0\,s)^2(9.8\,m/s^2)$

$= \boxed{2.23\ m}$

**3.** A 0.400 kg mass is attached to a horizontal spring such that as it moves on a frictionless surface it executes simple harmonic motion with period 0.76 s and amplitude 6.50 cm.




$m = 0.400\ \text{kg}$
$A = 6.50\ \text{cm}$

**a)** What is the force constant of the spring?

$T = 2\pi\sqrt{\frac{m}{k}} \rightarrow T^2 = 4\pi^2\frac{m}{k}$

$$\rightarrow k = \frac{4\pi^2 m}{T^2} = \frac{4\pi^2 (0.400\ \text{kg})}{(0.76\ \text{s})^2} = \boxed{27.3\ \frac{\text{kg}}{\text{s}^2} = 27.3\ \frac{\text{N}}{\text{m}}}$$

**b)** What is the total mechanical energy of the system?

$E = \{PE\}_{x=A} = \frac{1}{2}kA^2$

$= \frac{1}{2}(27.3\ \frac{\text{N}}{\text{m}})(0.0650\ \text{m})^2 = \boxed{5.78\times10^{-2}\ \text{J}}$

KE = 0 when $x = A$

**c)** What is the speed of the mass as it passes through the equilibrium position ($x = 0$)?

At $x = 0$, PE = 0 & all energy is kinetic energy:

$E = \{KE\}_{x=0} = \frac{1}{2}mv^2 = 5.78\times10^{-2}\ \text{J}$

$$\rightarrow v^2 = \frac{2}{m}(5.78\times10^{-2}\ \text{J}) = \frac{2}{(0.400\ \text{kg})}(5.78\times10^{-2}\ \text{J}) = 0.289\ \frac{\text{m}^2}{\text{s}^2}$$

$\rightarrow \boxed{v = 0.537\ \frac{\text{m}}{\text{s}}}$

Can also use $v_{max} = A\omega = A(2\pi f) = 2\pi A/T$

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**You must show all your work and include the right units with your answers!**

$g = 9.8\ \frac{\text{m}}{\text{s}^2}$ $\quad 1\ \text{m} = 100\ \text{cm}$ $\quad 1\ \text{kg} = 1000\ \text{g}$ $\quad 2\pi\ \text{rad} = 360\ \text{deg}$

$\tau_{\text{net}} = I\alpha$ $\quad I_{\text{sphere}} = \frac{2}{5}MR^2$ $\quad I_{\text{disk}} = \frac{1}{2}MR^2$ $\quad L = I\omega$ $\quad v_{\text{cm}} = \omega R$ $\quad a_{\text{cm}} = \alpha R$

$\text{KE}_{\text{trans}} = \frac{1}{2}mv^2$ $\quad \text{KE}_{\text{rot}} = \frac{1}{2}I\omega^2$ $\quad \text{KE}_{\text{roll}} = \text{KE}_{\text{trans}} + \text{KE}_{\text{rot}}$

$F_{\text{spr}} = -kx$ $\quad \text{PE}_{\text{spr}} = \frac{1}{2}kx^2$ $\quad f = \frac{1}{T}$ $\quad \omega = 2\pi f = \frac{2\pi}{T}$ $\quad v_{\max} = A\omega$ $\quad a_{\max} = \omega^2 A$

$T = 2\pi\sqrt{\frac{g}{\ell}}$ $\quad T = 2\pi\sqrt{\frac{m}{k}}$ $\quad \lambda f = v$

$2\pi\sqrt{\ell/g}$