General College Physics I (PHY 103)

Exam 3

Fall 2018

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Equation Sheet

$x = x_0 + vt$	$\theta = \theta_0 + \omega t$
$v = v_0 + at$	$\omega = \omega_0 + \alpha t$
$x = x_0 + v_0 t + \frac{1}{2}at^2$	$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
$v^2 = v_0^2 + 2a(x - x_0)$	$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$
$F_{\text{net}} = ma$	$\tau_{\text{net}} = I\alpha$
$F_{\text{gravity}} = mg$	$F = -kx$
$V_x = V\cos\theta$	$x = x_0 \cos\omega(t - t_0)$
$V_y = V\sin\theta$	$v = -\omega x_0 \sin\omega(t - t_0)$
$V = \sqrt{V_x^2 + V_y^2}$	$a = -\omega^2 x_0 \cos\omega(t - t_0)$
$\tan\theta = V_y/V_x$	$\omega = \sqrt{k/m},\ \omega = \sqrt{g/l}$
$a_{\text{R}} = v^2/r$	$a_{\tan} = r\alpha$
$F = Gm_1m_2/r^2$	$f = 1/T$
$F_{\text{fr}} = \mu_k F_{\text{N}}$	$\omega = 2\pi f$
$F_{\text{fr}} \leq \mu_s F_{\text{N}}$	$v = \lambda/T$
$W = F_{\parallel}d = Fd_{\parallel} = Fd\cos\theta$	$\tau = rF_{\perp} = r_{\perp}F = rF\sin\theta$
$\text{KE} = \frac{1}{2}mv^2$	$\text{KE} = \frac{1}{2}I\omega^2$
$W_{\text{net}} = \Delta\text{KE}$	
$\text{PE}_{\text{grav}} = mgh$	$\Delta E_{\text{th}} = mc\Delta T$
$\text{PE}_{\text{spring}} = \frac{1}{2}kx^2$	$F_{\text{spring}} = -kx$
$\text{ME} = \text{KE} + \text{PE}$	$s = r\theta$
$W_{\text{net,NC}} = \Delta\text{ME}$	$v = r\omega$
$\mathbf{p} = m\mathbf{v}$	$L = I\omega$
$\Delta\mathbf{P} = \mathbf{F}_{\text{net,ext}}\Delta t$	

$g = 9.8\ \text{m/s}^2$

$G = 6.67 \times 10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2$

$R = 8.314\ \text{J/mol}\cdot\text{K} = 0.0821\ \text{L}\cdot\text{atm/mol}\cdot\text{K}$

$k = 1.38 \times 10^{-23}\ \text{J/K}$

1 mi = 1609 m

1 atm = 101,325 N/m^2

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$C = 2\pi r$$

$$A = \pi r^2$$

Earth mass	5.98×10^{24} kg
Moon mass	7.35×10^{22} kg
Sun mass	1.99×10^{30} kg
Earth radius (mean)	6.38×10^{6} m
Moon radius (mean)	1.74×10^{6} m
Sun radius (mean)	6.96×10^{8} m
Earth-Moon distance (mean)	3.84×10^{8} m
Earth-Sun distance (mean)	1.496×10^{11} m

Substance	Specific Heat (J/kg·°C)
Aluminum	900
Copper	390
Iron or steel	450
Lead	130
Silver	230
Water	
Ice (-5°C)	2100
Liquid (15°C)	4186
Steam (110°C)	2010

Substance	Melting Point (°C)	Heat of Fusion (J/kg)	Boiling Point (°C)	Heat of Vaporization (J/kg)
Water	0	333,000	100	2.26×10^{6}
Lead	327	25,000	1750	870,000

Object	Axis	Moment of Inertia
Solid cylinder	central axis	$I = \frac{1}{2}MR^2$
Cylindrical shell	central axis	$I = MR^2$
Solid ball	central axis	$I = \frac{2}{5}MR^2$
Rod	through center $\perp$ to rod	$I = \frac{1}{12}ML^2$
Rod	through end $\perp$ to rod	$I = \frac{1}{3}ML^2$

Question 1 (4 points) A bowling ball is dropped from a height h onto the center of a trampoline, which launches the ball back up into the air. How high will the ball rise? Explain.

Question 2 (4 points) Consider a pendulum (a mass at the end of a light string) swinging back and forth. Ignore air resistance. Is mechanical energy conserved? Explain how you know.

Question 3 (4 points) Consider two carts, of masses m and $2m$, at rest on an air track. If you push first one cart for 3 s and then the other for the same length of time, exerting equal force on each, which cart has more kinetic energy? Explain how you know.

Question 4 (4 points) Can the mass of a rigid object be considered concentrated at its CM for rotational motion? Explain.

Problem 1 (8 points) Estimate the work you do to mow a lawn 10 m by 20 m with a 50-cm-wide mower. Assume you push with a force of about 15 N.

Problem 2 (8 points) Rain is falling at the rate of 2.5 cm/h and accumulates in a pan. If the raindrops hit at 8.0 m/s, estimate the force on the bottom of a 1.0-m^2 pan due to the impacting rain which we assume does not rebound. Water has a density of 1000 kg/m^3.

Problem 3 (8 points) A cooling fan is turned off when it is running at 850 rev/min. It turns 1250 revolutions before it comes to a stop. (a) What was the fan's angular acceleration, assumed constant? (b) How long did it take the fan to come to a complete stop?