General College Physics I (PHY 103)

Exam 2

Fall 2018

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Equation Sheet

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

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

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

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

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

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) The force of gravity on a 2-kg rock is twice as great as that on a 1-kg rock. Why then doesn't the heavier rock fall faster?

Question 2 (4 points) A water balloon is launched into the air (do not ignore air resistance) at an angle above the horizontal and follows a parabolic trajectory until it smashes on the ground. Draw a free body diagram for the water balloon just after it leaves the launcher, and second free body diagram just before it hits the ground. Be sure to label which is which.

Question 3 (4 points) A box on the end of a string swings from side to side like a pendulum. When the string is vertical, compare the tension in the string to the weight of the box. (Which is bigger, or are they equal?) Explain how you know.

Question 4 (4 points) Can a particle with constant speed be accelerating? What if it has constant velocity? Explain.

Problem 1 (8 points) What average force is required to stop a 950-kg car in 8.0 s if the car is traveling at 95 km/h?

Problem 2 (8 points) What is the period of a person on a carousel if the person has an acceleration of 2.5 m/s^2 when she is standing 2.7 m from the axis?

Problem 3 (8 points) What will a spring scale read for the weight of a 58.0-kg woman in an elevator that moves (a) upward with constant speed 5.0 m/s, (b) downward with constant speed 5.0 m/s, (c) with an upward acceleration $0.23g$, (d) with a downward acceleration $0.23g$, and (e) in free fall?