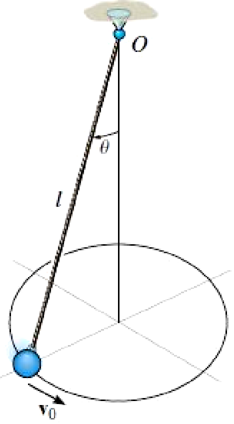
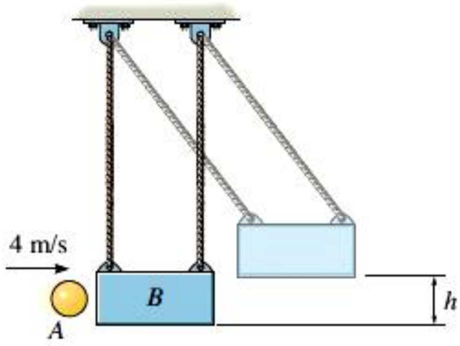
AMERICAN UNIVERSITY IN CAIRO
ENGR 214: Engineering Mechanics II (Dynamics)
Final Exam, 29 May, 2011

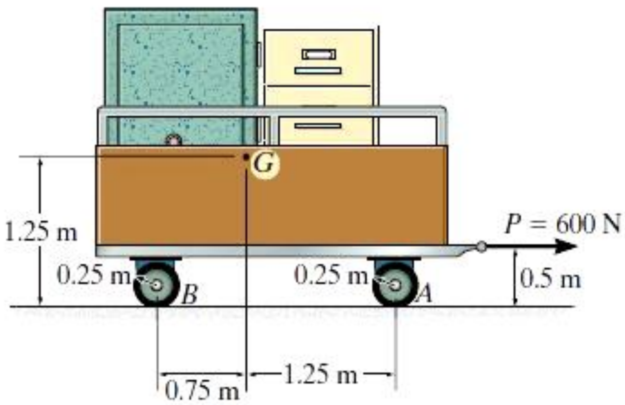
1. (25) The ball has a mass *m* and is attached to the cord of length *l*. The cord is tied at the top to a swivel and the ball is given a velocity *v*. Show that the angle θ which the cord makes with the vertical as the ball travels around the circular path must satisfy the equation: $\tan\theta\sin\theta = v^2/gl$.



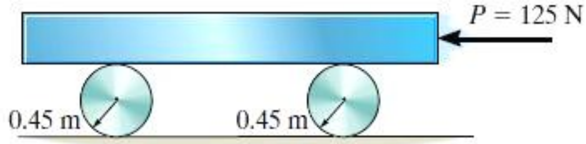
2. (25) The 2-kg ball is thrown at the suspended 20-kg block with a velocity of 4 m/s. If the time coefficient of restitution between the ball and the block is e = 0.8, determine the maximum height *h* to which the block will swing before it momentarily stops.



3. (25) The trailer with its load has a mass of 150 kg and a center of mass at *G*. If it is subjected to a horizontal force *P* = 600 N, determine the trailer's acceleration and the normal force on the pair of wheels at *A* and *B*. The wheels are free to roll and have negligible mass.



4. (25) The 50-kg block is transported a short distance by using two cylindrical rollers, each having a mass of 17.5 kg. If a horizontal force *P* = 125 N is applied to the block, determine the block's speed after it has been displaced 0.6 m to the left. Originally the block is at rest. No slipping occurs.



Equation Sheet

$v = \frac{dx}{dt}$ $\qquad$ $a = \frac{dv}{dt} = \frac{d^2x}{dt^2} = v\frac{dv}{dx}$

Uniform rectilinear motion

$x = x_0 + vt$

Uniformly accelerated rectilinear motion

$v = v_0 + at$

$x = x_0 + v_0 t + \frac{1}{2}at^2$

$v^2 = v_0^2 + 2a(x - x_0)$

Acceleration components

Tangential & normal: $\quad a_t = \frac{dv}{dt} \qquad a_n = \frac{v^2}{\rho}$

Radial and transverse: $\quad a_r = \ddot{r} - r\dot{\theta}^2 \qquad a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$

Work and energy: $T_1 + U_{1\to 2} = T_2$

Conservation of energy: $T_1 + V_1 = T_2 + V_2$

Impulse and momentum: $m\vec{v}_1 + \int_{t_1}^{t_2} \vec{F}dt = m\vec{v}_2$

Coefficient of restitution: $e = \frac{v'_B - v'_A}{v_A - v_B}$

$\vec{v}_B = \vec{v}_A + \vec{v}_{B/A} = \vec{v}_A + \vec{\omega} \times \vec{r}_{B/A}$

$\vec{a}_B = \vec{a}_A + \vec{a}_{B/A} = \vec{a}_A + \left(\vec{a}_{B/A}\right)_n + \left(\vec{a}_{B/A}\right)_t$

$(a)_t = r\alpha \qquad (a)_n = r\omega^2$

$\sum \vec{F} = m\vec{a}_G \qquad \sum \vec{M}_G = I_G\vec{\alpha}$

For a uniform cylinder, $I_G = \frac{1}{2}mr^2$