Sample Physics 130-1 Placement Exam

A. Multiple Choice Questions:

1. A cable is used to take construction equipment from the ground to the top of a tall building. During the trip up, when (if ever) is the tension in the cable less than the weight of the equipment?

a. at the beginning of the trip, when the equipment is first moving upward from the ground
b. during the middle part of the trip, when the equipment is moving upward with constant speed
c. at the end of the trip, when the equipment is slowing to come to a halt.
d. The tension is never less than the weight of the equipment.

2. A boy whirls a stone in a horizontal circle above his head by means of a long string. As the stone moves, the force of tension in the string does work that is:

a. positive b. negative c. zero

3. A kid stands at the left edge of a uniform sled of length L, which is stationary on frictionless ice. The sled and kid have equal masses. The kid walks to the right edge of the sled and the sled slides on the ice. Afterwards, how far and in what direction is the center of the sled from the center of mass of the sled-kid system?

a. L/8, to the left b. L/8, to the right c. L/4 to the left d. L/4, to the right
e. L/2, to the left f. L/2, to the right g. none of the above

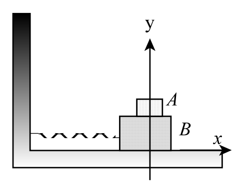
4. A block slides down inclined plane #1. A ball rolls down inclined plane #2. Inclined plane #1 is identical to inclined plane #2 (same height & slope) except that inclined plane #1 is frictionless and inclined plane #2 is not. The block and the ball have the same mass and both start from the top of their inclined planes. Which object is moving faster (has greater translational speed) at the bottom of its incline?

a. the block b. the ball c. The block & the ball have the same speed

5. A man stands on a platform that is rotating (without friction) with an angular speed of ω. His arms are outstretched and he holds a brick in each hand. The man then pulls his arms in and holds the bricks close to his body. As he does this, how does the angular speed ω of the platform change?

a. ω increases b. ω decreases c. ω stays the same

6. A small block *A* sits on a large block *B* which rests on top of a frictionless table. Although there is no friction between block *B* and the table, there is ***nonzero*** friction between block *A* and block *B*. Initially, the spring is at rest and block *B* is at the origin of an *x-y* coordinate system, with the *x* -axis running along the table. We then pull the block to the right and let it go. As the system undergoes simple harmonic motion with amplitude x_{max}, block *A* is on the verge of slipping over *B*. When is slippage most likely?



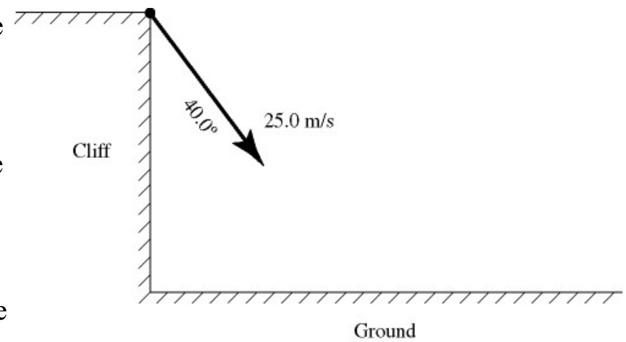
a. at $x = 0$ b. at $x = x_{max}$ c. somewhere between $x = 0$ & $x = x_{max}$ d. equally likely at all points

7. If several cans of different sizes and shapes are all filled with the same liquid to the same depth, then:

a. the weight of the liquid is the same for all cans.
b. the force of the liquid on the bottom of each can is the same.
c. the least pressure is at the bottom of the can with the largest bottom area.
d. the greatest pressure is at the bottom of the can with the largest bottom area.
e. the pressure on the bottom of each can is the same.

B. Multiple Choice Problems:

1. A hiker throws a stone from the upper edge of a vertical cliff. The stone's initial velocity is 25.0 m/s directed at 40.0º with the face of the cliff, as shown in the figure at right. The stone hits the ground 3.75 s after being thrown and feels no appreciable air resistance as it falls. In this situation the height of the cliff is closest to which of the following answers?



a. 60.3 m **b.** 71.8 m **c.** 129 m
d. 141 m **e.** 163 m **f.** none of the above

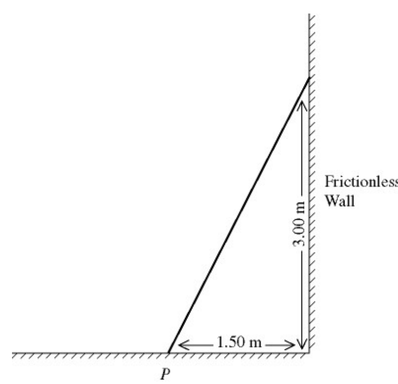
2. A long-distance swimmer is able to swim through still water at 4 km/h. She wishes to try to swim from Port Angeles, WA, due north to Victoria, B.C., a distance of 50 km. An ocean current flows through the Strait of Juan de Fuca from west to east at 3 km/h. In what direction should she swim to make the crossing along a straight line between the two cities?

a. 41° east of north **b.** 37° west of north **c.** 37° east of north
d. 41° west of north **e.** 49° west of north **f.** none of the above

3. At what angle should the roadway on a curve with a 50m radius be banked to allow cars to negotiate the curve at 12 m/s even if the roadway is icy (and the frictional force is zero)?

a. 0 **b.** 16° **c.** 18° **d.** 35° **e.** 73°

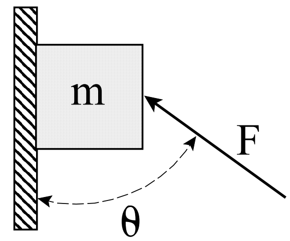
4. A ladder leans against a perfectly frictionless wall, as shown in the figure at right. You determine that the magnitude of the force that the wall exerts on the ladder is 100.0 N. The torque that this force exerts about the foot of the ladder (point P) is closest to which of the following?



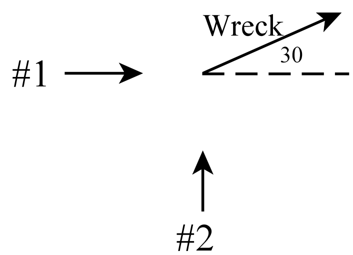
a. 300 N·m **b.** 335 N·m **c.** 2940 N·m **d.** 1470 N·m **e.** 150 N·m

C. Free Response Problems:

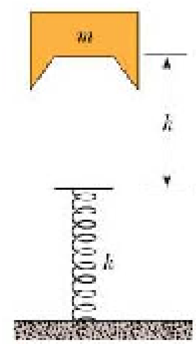
1. A block of mass m = 5.0 kg is held against the wall by a person who applies a force F that is inclined by an angle $\theta = 60^{\circ}$ to the wall. There is friction between the block and the wall, and the coefficient of static friction is 0.30. For what values of F will the block remain stationary and not slide along the wall? Recall that the acceleration due to gravity near the Earth's surface is 9.8 m/s^2.



2. Automobile #1 (1090 kg) is traveling due east when it collides with automobile #2 (1294 kg), traveling due north, at an intersection. The wrecked autos meld together and, wheels locked, skid off 30° north of east for 18.6 meters before coming to rest. The coefficient of kinetic friction between the tires and the pavement is 0.80. What was the speed of each automobile immediately before the collision? Show all work in the blank space below and write your final answers at the bottom of the page in the boxes.



3. A block of mass m = 0.5 kg is dropped from a height h above a vertical spring having a force constant of 1960 N/m. The speed of the block right before impact with the spring is 12.4 m/s. The effects of air friction are negligible.



a. What was h?

b. Find the maximum compression "d" of the spring when the block comes to rest.

c. What is the distance between the point of the first block-spring contact and the point where the block's speed is greatest?

Useful Facts

$v = v_o + at$

$x = x_o + v_o t + \frac{1}{2}at^2$

$v^2 = v_o^2 + 2a(x - x_o)$

$\bar{v} = \dfrac{v + v_o}{2}$

$\sum \vec{F} = m\vec{a}$

$f_k = \mu_k N$ (kinetic frict $f_s \leq \mu_s N$ (static friction)

$a_R = \dfrac{v^2}{r}$ $T = \dfrac{1}{f}$ $v = \dfrac{2\pi r}{T}$ $\sum F_R = ma_R = m\dfrac{v^2}{r}$ (Circular Motion)

$N \sin\theta = m\dfrac{v^2}{r}$ (Banking)

$F = G\dfrac{m_1 m_2}{r^2}$ (Gravity)

$W = Fd\cos\theta$ $W_{\text{net}} = \Delta K$ $K = \frac{1}{2}mv^2$ (Work/Energy)

$U_{\text{grav}} = PE_{\text{grav}} = mgy$ $U_{\text{spring}} = \text{elastic PE} = \frac{1}{2}kx^2$ (Potential Energy)

$\overline{P} = \dfrac{W}{t} = \dfrac{Fd}{t} = F\overline{v}$ (Power)

$\vec{p} = m\vec{v}$ (Linear Momentum) $\text{Impulse} = \vec{F}\Delta t = \Delta\vec{p}$

$Mx_{CM} = \sum_{i=1}^{N} m_i x_i$ (Center of Mass)

$m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{v}_1{}' + m_2\vec{v}_2{}'$ (Conservation of Linear Momentum)

$\frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2 = \frac{1}{2}m_1 v_1'^2 + \frac{1}{2}m_2 v_2'^2$ (Elastic Collision) $v_1 - v_2 = v_2' - v_1'$ (head-on)

$v_2' = \dfrac{2m_1 v_1}{m_1 + m_2}$ $v_1' = v_2' - v_1$ (head-on; target m_2 at rest)

$\theta = \frac{l}{r}$ $\quad \overline{\omega} = \frac{\Delta\theta}{\Delta t}$ $\quad \overline{\alpha} = \frac{\Delta\omega}{\Delta t}$ (Angular variables)

$v = r\omega$ $\quad a_{\tan} = r\alpha$ $\quad a_R = \frac{v^2}{r} = \omega^2 r$ $\quad \vec{a} = \vec{a}_{\tan} + \vec{a}_R$ (Rigid Body Rotation)

$\omega = \omega_o + \alpha t$ $\quad \Delta\theta = \omega_o t + \frac{1}{2}\alpha t^2$

$\omega^2 = \omega_o{}^2 + 2\alpha\theta$ $\quad \overline{\omega} = \frac{1}{2}(\omega + \omega_o)$ (Constant α)

$v_{cm} = \omega r$ (Rolling)

$\tau = r_\perp F = rF_\perp = rF \sin\theta$ (Torque) $\quad \sum \tau = I\alpha$ $\quad W = \tau\Delta\theta$

$I = \sum mr^2$ (Moment of Inertia) $\quad K_{rot} = \frac{1}{2}I\omega^2$ (Kinetic Energy)

$I = (2/5)MR^2$ (solid sphere about any diameter)
$I = ½\, MR^2$ (solid cylinder about central axis)
$I = (1/12)\, ML^2$ (thin rod about axis through center perpendicular to length)

$L = I\omega$ (Angular Momentum) $\quad I_o\omega_o = I\omega$ (Zero net torque)

$\sum \vec{F} = 0$ $\quad \sum \vec{\tau} = 0$ (Conditions for static equilibrium)

$\rho = \frac{m}{V}$ (Density) $\quad P = \frac{F}{A}$ (Pressure)

$\Delta P = \rho g\, \Delta h$ (Change in pressure with change in depth)

Pascal: Pressure applied to a confined fluid increases the pressure throughout by the same amount.

Archimedes: The buoyant force on a body immersed in a fluid is equal to the weight of the fluid displaced by that object.

$F = -kx$ (Spring Force) $\quad f = \frac{1}{T}$ (Frequency/Period relationship)

$E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kA^2 = \frac{1}{2}mv_o{}^2$ (Energy in Simple Harmonic Motion)

$T = 2\pi\sqrt{\frac{m}{k}}$ $\quad \omega = 2\pi f$ (Mass-spring)

$f = \frac{1}{2\pi}\sqrt{\frac{g}{L}}$ (Simple Pendulum)