You are subject to the Bryn Mawr College honor code while taking this exam. This is a closed book exam. You may use a simple calculator and a pencil during this exam, but nothing else. Do all questions on the exam. Do all work directly on the examination, in the space provided. If you run out of room, you may use the back of the page. Be sure to answer all parts of each question. Some problems will take longer than others, but all will be weighted equally when graded. When providing a sketch, please be as neat, accurate, and quantitative as possible. A sloppy sketch indicates misunderstanding and will receive a reduced grade. The final page of this exam provide several potentially useful equations. You may remove this page for easy reference.

This exam will be available between Friday, 27 February 2015 and Monday, 2 March 2015, at the reserve desk in the Collier Science Library during normal library operating hours. I will collect all of the exams Tuesday morning when the library opens. Take the exam during a single 90 minute sitting in the library.

Before you begin, write your name in the space below and at the top of EVERY page of this exam, note the date in the space provided on this page, and note the time. When you finish, note the time and return the exam to the circulation desk. The difference between your start and finish times should be no more that 90 minutes.

Name:

Date:

Start time:

Finish time:
1. A block is heading up a ramp with an initial speed of 4.0 m/s. The ramp is inclined at an angle of 37° with respect to the horizontal table. The coefficient of kinetic friction between the block and the ramp is \( \mu_k = 0.25 \). How far up the ramp will it go? How much time elapses as the block travels up the ramp and back down to its starting point? \[ \sin(37°) = 0.60, \cos(37°) = 0.80 \]
2. Use the cross product to find the components of the unit vector \( \hat{n} \) perpendicular to the plane shown in the figure below.
3. In a “Rotor-ride” at a carnival, people pay money to be rotated in a vertical cylindrically walled “room.” They stand against the walls of the room, which has a radius of 5 m. When the rotation frequency of the room reaches 0.5 rev/s, the floor drops out. What is the minimum coefficient of static friction that will keep the people from slipping down the wall?
4. You are in an elevator that is rising at constant velocity. Suddenly you drop your keys. It so happens that when they strike the floor they are as high above the ground level as when they left your hand. The keys fall dead on the floor without bouncing. Make a single graph showing qualitatively the height above the ground of both the keys and the elevator as a function of time, starting from before the keys are released and ending after they strike the floor.

Make a single graph showing qualitatively the velocity of both the keys and the elevator as a function of time for the same time interval as in your space-time graph.
Potentially useful equations

\[ v_x = v_{0x} + a_xt \]
\[ x = x_0 + v_{0x}t + \frac{1}{2}a_xt^2 \]
\[ v_x^2 = v_{0x}^2 + 2a_x(x - x_0) \]

\[ r = r\dot{r} \]
\[ \mathbf{v} = \dot{r}\mathbf{r} + r\dot{\theta}\mathbf{\hat{\theta}} \]
\[ \mathbf{a} = (\ddot{r} - r\dot{\theta}^2)\mathbf{r} + (r\ddot{\theta} + 2r\dot{\theta})\mathbf{\hat{\theta}} \]

\[ a_c = \frac{v^2}{r} = \omega^2 r \]
\[ v = r\omega \]
\[ \omega = 2\pi f = \frac{2\pi}{T} \]

\[ \mathbf{F} = ma \]
\[ F_{friction} = \mu N \]
\[ W = mg \]
\[ F_s = -kx \]
\[ F_{grav} = \frac{G M_a M_b}{r^2} \]

for \( \ddot{q} + \omega^2 q = 0 \), \( q(t) = A \sin(\omega t + \phi) \)

\[ \mathbf{A} \cdot \mathbf{B} = |\mathbf{A}||\mathbf{B}| \cos \theta \]
\[ \mathbf{A} \cdot \mathbf{B} = A_xB_x + A_yB_y + A_zB_z \]
\[ |\mathbf{A} \times \mathbf{B}| = |\mathbf{A}||\mathbf{B}| \sin \theta \]
\[ \mathbf{A} \times \mathbf{B} = i(A_yB_z - A_zB_y) - j(A_xB_z - A_zB_x) + k(A_xB_y - A_yB_x) \]

\[ g = 10 \text{ m/s}^2 \]
\[ G = 6.673 \times 10^{-11} \text{ m}^3\text{kg}^{-1}\text{s}^{-2} \]

for \( ax^2 + bx + c = 0 \), \[ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]