

Ph205 Final exam

1:30 – 4:30 p.m.

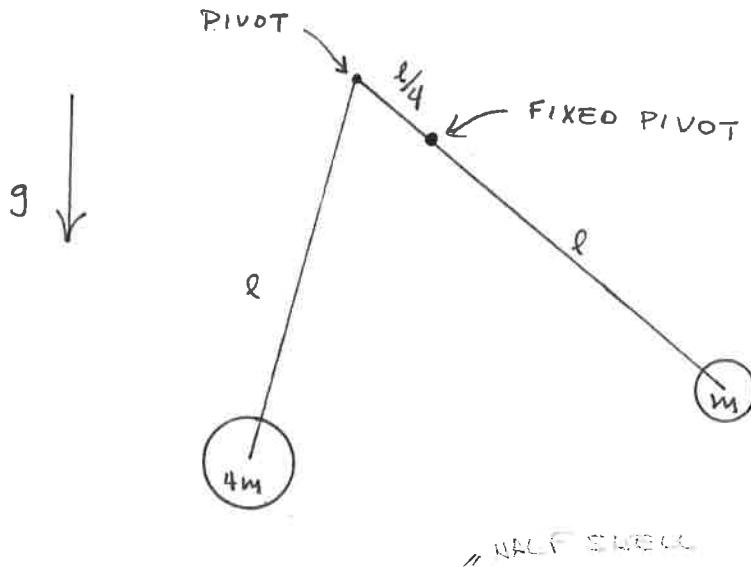
Jan. 25, 1991

Palmer 306A

- This exam consists of 4 questions, each worth 10 points.
- The exam is closed book, closed notes.
- Please do all work you wish graded in the exam booklets provided.

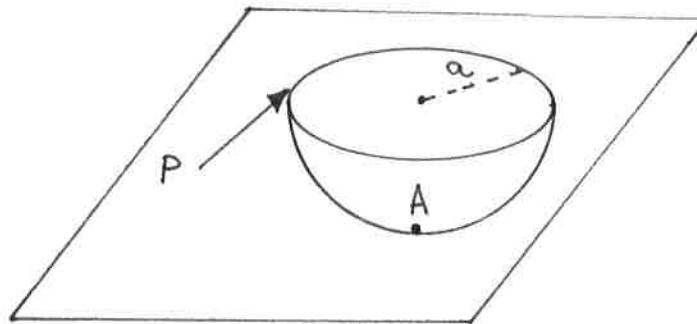
1. A massless rod of length $5l/4$ has a mass m on one end, at is free to move in a vertical plane about a pivot point $l/4$ from the other end. A massless rod of length l has a mass $4m$ on one end and its other end is attached to the free end of the first rod. The two rods then can move in the same vertical plane. Find the frequencies of the normal modes of oscillation of the system.

(This problem is only loosely related to the child's toy on display.)



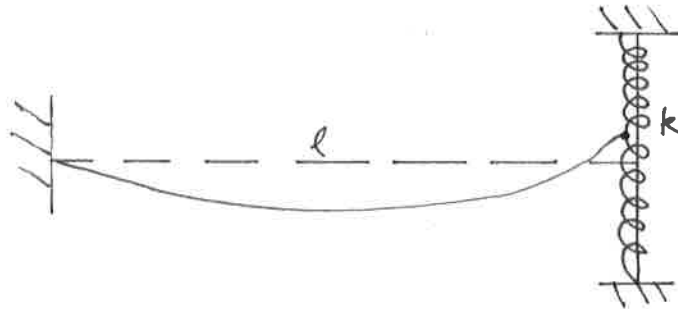
2. A thin hemispherical bowl of mass m and radius a rests on a smooth horizontal plane. A horizontal impulse of magnitude P is applied along a tangent to the rim. Find the magnitude and direction of the velocity of point A on the bowl just after the impulse, where point A was initially the point of contact of the bowl and the plane.

SHOW THAT THE RIM OF THE BOWL NEVER TOUCHES THE PLANE IN THE SUBSEQUENT MOTION



THE MIDPOINT OF

3. A string of length l and uniform linear mass density ρ is stretched with tension T between a fixed point and a spring of constant k . The spring is constrained to move transversely to the equilibrium direction of the string. Deduce an expression for the frequencies of the normal modes. Estimate the second lowest frequency if $T \gg kl$, and sketch the corresponding mode.



4. A bead of mass m slides freely on a surface of revolution about the vertical z axis which has the shape $z = a \sin kr$. Find the frequency of stable oscillations about circular motion for $r < \pi/(2k)$, and the maximum value of r for which such stable oscillations can occur.

