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University of California, Berkeley

Physics 105 Spring 1987
Midterm #2 Section 1 Wed. 22 April

1. A comet at a distance of 1.000×10^8 km from the Sun is observed to travel at a speed of 51.6000 km/s. Its velocity vector makes an angle of 45° with respect to the sun-comet line. Useful information: The escape speed from Sun's gravity at a distance r' astronomical units (A.U.) is

$$V_{esc} = \frac{42.131224 \text{ km/s}}{\sqrt{r'}}$$

1 A.U. = 1.5000×10^8 km; $GM_\odot = 1.3273 \times 10^{20}$ MKS. $M_\odot$ is the mass of the Sun.

(a) What is the total energy of this comet?

(b) Find the distance of closest approach to the Sun (r_{MIN}).

(c) Find the equation of the comet's orbit. You may choose $\theta = 0$ at $r = r_{MIN}$.

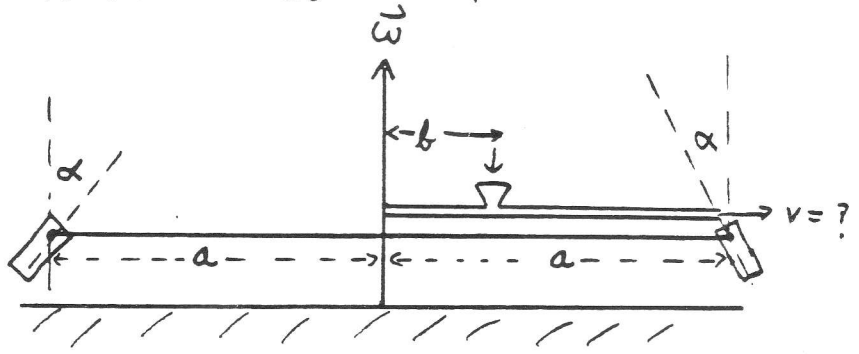
2. Centrifuges are sometimes used to study effects of accelerations much larger than $g = 9.8$ m/s^2 on animals. Hinged cages are placed at the ends of arms of length a. The arms rotate in a horizontal plane at angular speed ω. Assume the size of the cages is << a.

(a) At what angle with respect to the vertical do the cages hang?

(b) What is the apparent weight of a mouse of mass m?

(c) The mice must be fed. Food pellets are poured into a smooth walled, horizontal tube at a distance b from the axis of rotation. At what speed are the pellets moving when they reach the cages?

(d) FIND THE FORCE EXERTED BY THE WIRE ON THE BEAD.



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3. A bead of mass m slides without friction on a circular wire hoop of radius a. The hoop is placed in a vertical plane and it is rotated at constant angular speed ω. The acceleration due to gravity is g.

(a) Write an expression for the Lagrangian function of this system.

(b) Find all positions for which the bead is in equilibrium. State the condition or conditions for which each is an equilibrium position.

(c) Find the frequency of small angle oscillations about one of the equilibrium positions.