University of California at Berkeley

Physics 105 Spring 1989
Midterm Exam #2 Monday 24 April 1989

Each Question is worth 20 points

1) Two spheres of unequal mass move with equal speeds toward one another. After colliding one of the spheres is at rest. Assume the collision is elastic.

   a) Find the ratio of the masses
   b) Which of the two spheres is brought to rest, the lighter or the heavier one?

2) Satellites in geosynchronous orbits are of great importance in communications and weather forecasting. Such orbits lie in Earth's equatorial plane and have constant angular velocity equal to that of Earth. The satellite then remains stationary over a particular point on the Earth's equator.

   a) Calculate the ratio (Rs/RE) to three significant figures. (Rs is the radius of the synchronous orbit, R_e is the radius of the Earth = 6.37×10^6 m). In finding your answer use only 1 day = 24 hours, g = 9.8 m/s² and the radius of Earth.

   b) Calculate the kinetic energy per unit mass of a satellite in geostationary orbit.

   c) Calculate the total energy per unit mass of a satillite in geostationary orbit

   d) Consider an <u>elliptical</u> orbit about the Earth with period τ = 24 hours and eccentricity $\varepsilon = 3/5$. Find:

      i) The semi-major axis, a/R_E

      ii) Total energy per unit mass

      iii) Maximum distance from Earth's center.

      iv) Minimum distance from Earth's center.

3) An interplanetary space station of cylindrical shape is rotated to provide "artificial gravity". The radius of the cylinder is 30 m.

   a) What should be the period of rotation in order to provide acceleration equal to 0.7g at the cylinder wall? ($g = 9.8\ m/r^2$).

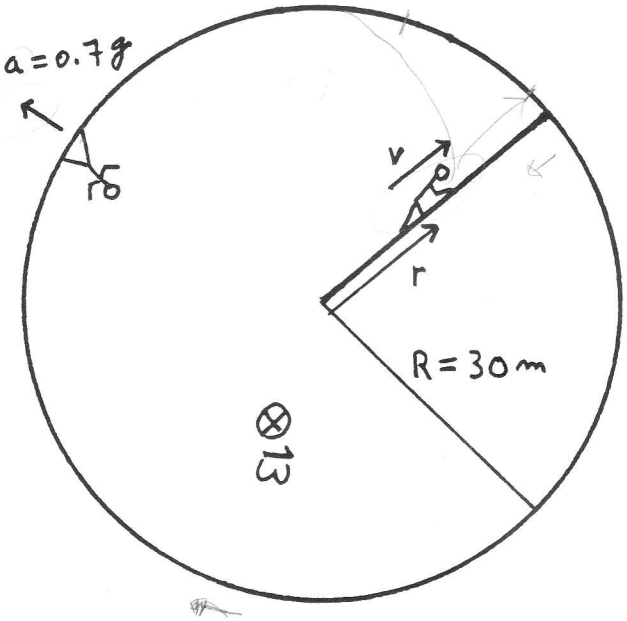
   b) Suppose one of the astronauts climbs a ladder extending from the axis of the cylinder to its wall. find the forces that must be supplied by the ladder as the astronaut climbs the ladder at a constant speed of 1 m/s. The mass of the astronaut is 70 kg.

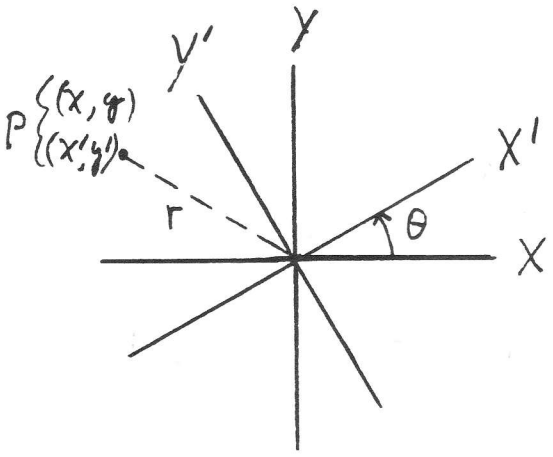
CONTINUE ON REVERSE

c) Half way up the ladder the astronaut stops to repair an equipment item. He/she drops a screwdriver (initially at rest with respect to the ladder).

d) What path does the screwdriver follow as seen by an observer in an inertial frame?

e) Find the equation of the path as seen by an observer in the rotating spacecraft. (Suggestion: Express path in polar coordinates, r and θ.)





$$x' = x\cos\theta + y\sin\theta$$

$$y' = -x\sin\theta + y\cos\theta$$