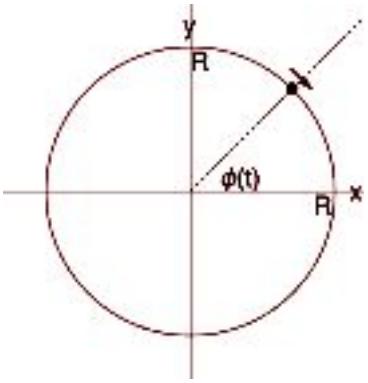
[37] THREE EXAM QUESTIONS; hand in full solutions.



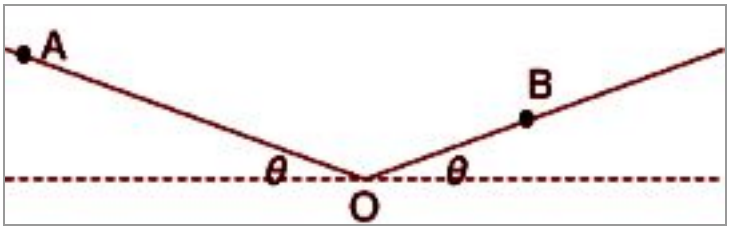
(1) A particle moves on a circular orbit in the xy-plane, and the angle $\phi(t) = \pi/2 - \omega t$.

Use Cartesian coordinates.

(a) Calculate the vectors **r**(t), **v**(t) and **a**(t).

(b) What is the force on the particle when it is at the position (x,y) = (R,0)?

(2) A bicycle rider coasts down a long slope from point A to point O, with quadratic air resistance. The angle of the slope is θ . At point O the speed of the bicycle is equal to the terminal speed v_T for the slope.



Then the bicyclist coasts ***up*** the slope from O to B, which has the same angle; the speed at B is 0.

(a) Determine the terminal speed v_T.

(b) Determine the time to coast from O to B.

(3) The first ballistic missiles were rockets with these parameters:

mass at lift-off = 12,500 kg ; payload mass = 1,000 kg;

thrust = 250,000 newtons;

burn time = 65 seconds

(a) Calculate relative speed of the exhaust gases.

(b) Calculate the velocity of the rocket at burn-out.