Kinematics

Question 1 The Cartesian coordinates of a particle on the plane are given by

$$x = t\cos t \qquad y = -t\sin t \qquad t : 0 \to \pi$$

Find the velocity and acceleration of the particle. *2005 paper.*

Question 2 A cyclist sets out with velocity $v_0 = 30\,\mathrm{km\,hr}^{-1}$, and decelerates with $a = -10\,\mathrm{km\,hr}^{-2}$ until he stops. He rests for one hour and then cycles in the opposite direction for four hours with constant velocity $v_1 = 20\,\mathrm{km\,hr}^{-1}$.

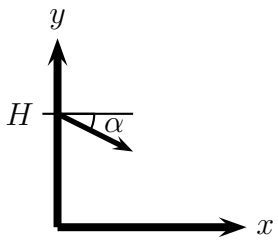
(a) Draw the graphs of the velocity and displacement of the cyclist vs. time.

(b) Find how far the cyclist ends up from his starting point.

(c) Find the total distance covered by the cyclist and his mean velocity.

2005 paper.

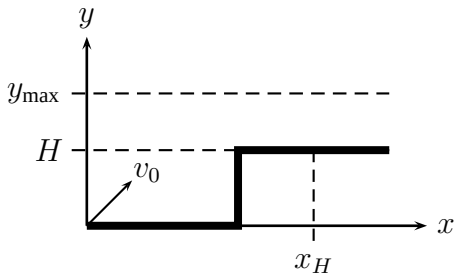
Question 3



A stone is thrown with velocity v_0, at an angle α to the horizontal, from a 'step' of height H. Calculate the x coordinate of the point where the stone hits the ground.

2005 paper.

Question 4



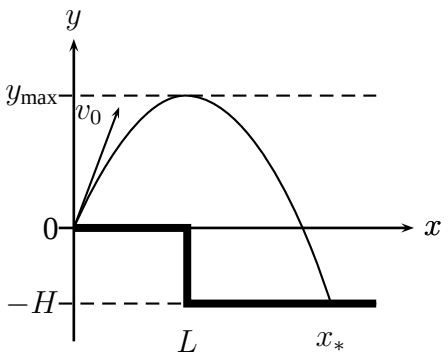
A stone is projected (under gravity, with air friction neglected) with velocity v_0, at an angle α to the horizon, towards a 'step' of height H:

(a) Assuming the stone goes over the step, calculate $y_{\max}$ (the maximum height of the stone's trajectory) and x_H (the x-coordinate of the point where it hits the ground).

(b) Determine for which v_0 the stone would go over the step.

2006 paper.

Question 5



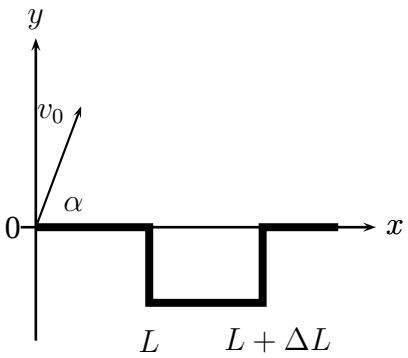
A stone is projected (under gravity, with air friction neglected) with velocity v_0, at an angle α to the horizon, towards a 'pit' of depth H located at a distance L.

(a) Determine for which v_0 the stone would reach the pit.

(b) Assuming that the stone reaches the pit, calculate x_* (the x-coordinate of the point where the stone hits the ground) and $y_{\max}$ (the maximum height of the trajectory).

2007 paper.

Question 6



A stone is projected (under gravity, with air friction neglected) with velocity v_0, at an angle α to the horizon, towards a 'pit' of width ΔL located at a distance L.
Find the values of α for which the stone ends up inside the pit.

2008 paper.