

NS540 Worksheets for session 4 (at-home session) due at session 5

NAME: _____

Motion in Two Dimensions

Can we apply anything we learned from motion in 1-D to motion in 2-D?

Constant-acceleration equations

Equation from 1-D	2-D: X equations	2-D: Y equations
$v = v_i + at$	$v_x = v_{ix} + a_x t$	$v_y = v_{iy} + a_y t$
$x = x_i + v_i t + \frac{1}{2} at^2$	$x = x_i + v_{ix} t + \frac{1}{2} a_x t^2$	$y = y_i + v_{iy} t + \frac{1}{2} a_y t^2$
$v^2 = v_i^2 + 2a(\Delta x)$	$v_x^2 = v_{ix}^2 + 2a_x(\Delta x)$	$v_y^2 = v_{iy}^2 + 2a_y(\Delta y)$

Let's fire a ball straight up from the ground, giving it an initial velocity of 30 m/s up.

Use $g = 10 \text{ m/s}^2$ to keep the calculations simple.

What is the ball's acceleration?

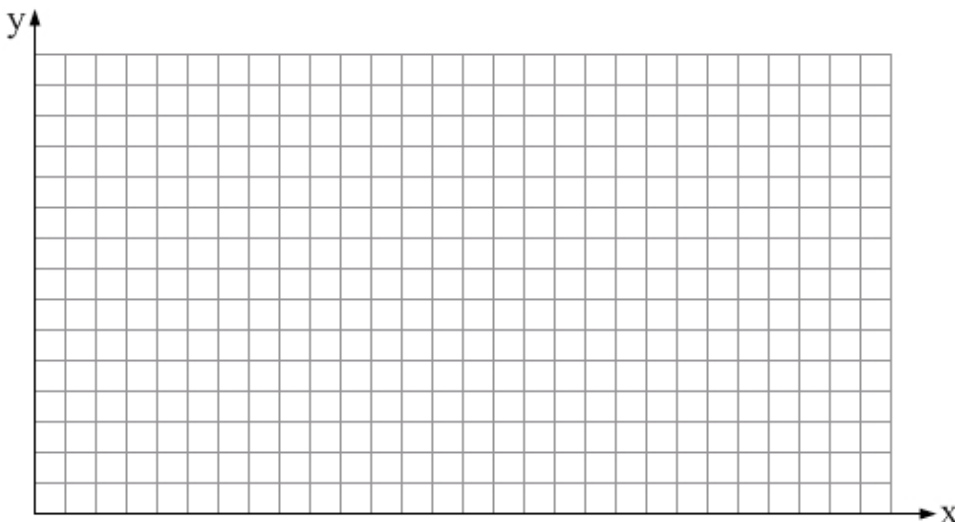
How long does the ball spend in the air before it returns to the ground?

On the graph below, plot the position of the ball at 1-second intervals, starting at the instant it leaves the ground until it returns to the ground.

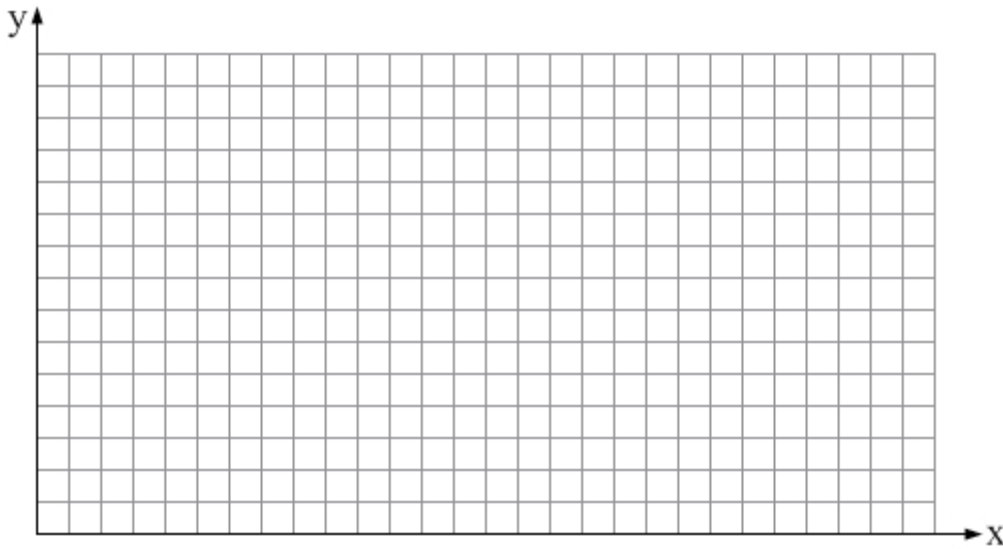
Now let's look at the motion of an object that travels at a constant velocity of 20 m/s in the positive x -direction, starting from the origin. What is this object's acceleration?

On the graph below, plot the position of the object at 1-second intervals for the same time period that we followed the ball fired straight into the air.

The squares on this grid measure 5 m x 5 m.



The squares on this grid measure 5 m x 5 m.



Re-create the graph from the other side here.

Now plot the position, at 1 second intervals, of a ball we fire from the origin so that its initial velocity has components of $v_{ix} = 20$ m/s in the +x direction and $v_{iy} = 30$ m/s straight up.

Which ball is in the air longer, the one we fired straight up or this one, which has both x and y components? Briefly explain your answer.

Now plot the position, at 1 second intervals, of a ball we fire from the origin so that its initial velocity has components of $v_{ix} = 10$ m/s in the +x direction and $v_{iy} = 30$ m/s straight up. Use a different symbol to mark these points on the diagram.

In this special case in which the projectile starts and ends at the same height, what determines the time an object spends in the air? Select all that apply.

v_{ix} v_{iy} What planet it's on.

Determine an equation for the time spent in the air.

What determines the maximum height reached by a projectile? Select all that apply.

v_{ix} v_{iy} What planet it's on.

Determine an equation for the maximum height.

Phet simulation exercise, using “Forces in 1 Dimension”

You can either google “Phet simulations” to find this simulation, or use the link to the Phet simulation “Forces in 1 Dimension” from the NS540 site, <http://physics.bu.edu/~duffy/NS540.html>

When you are on the simulation page for “Forces in 1 Dimension” simulation, scroll down to the “Ideas and Activities for this Sim”

Click on the 4th item in the list of activities, the activity by T. Loblein, titled “Forces 1D Activity 1: Predicting Speed and Direction Changes”

That will take you to a new page, where you will find a list of six documents.

1. First, get the “Check your understanding before Forces 1D Activity”, and fill that out.
2. Then, with the help of the simulation, complete the activity titled “Student directions for 1D changing speed and direction.”

You will hand in these worksheets at the next session.

Don’t forget to explore the Phet site for lots more great simulations.

Building assignment – make a water clock

For session 5, please bring in a water clock (a device that uses water to time something) that you have made yourself. This is how Galileo did much of the timing for his experiments.