

# Ready, Set, Jump!



**Figure 1** Basketball player making a jump shot

We are all impressed by athletes with long hang times, especially in sports such as basketball. The player most famous for hang time is probably Michael Jordan, with a hang time of 0.92 seconds—nearly a second!

How can you accurately measure hang time? Can you determine the maximum jump height from the hang time? Who can jump the highest in your class? How does your hang time compare to Michael Jordan?

## Initial Ideas

1. What factors affect hang time and jump height?
2. What tools could you use to measure hang time?

3. How could you determine the maximum height of a vertical jump?

## How can you measure hang time accurately?

There are many different ways to measure time. It is important to use a tool that has an appropriate degree of precision and accuracy.



**Figure 2** Stopwatch



**Figure 3** Go Direct Force Plate

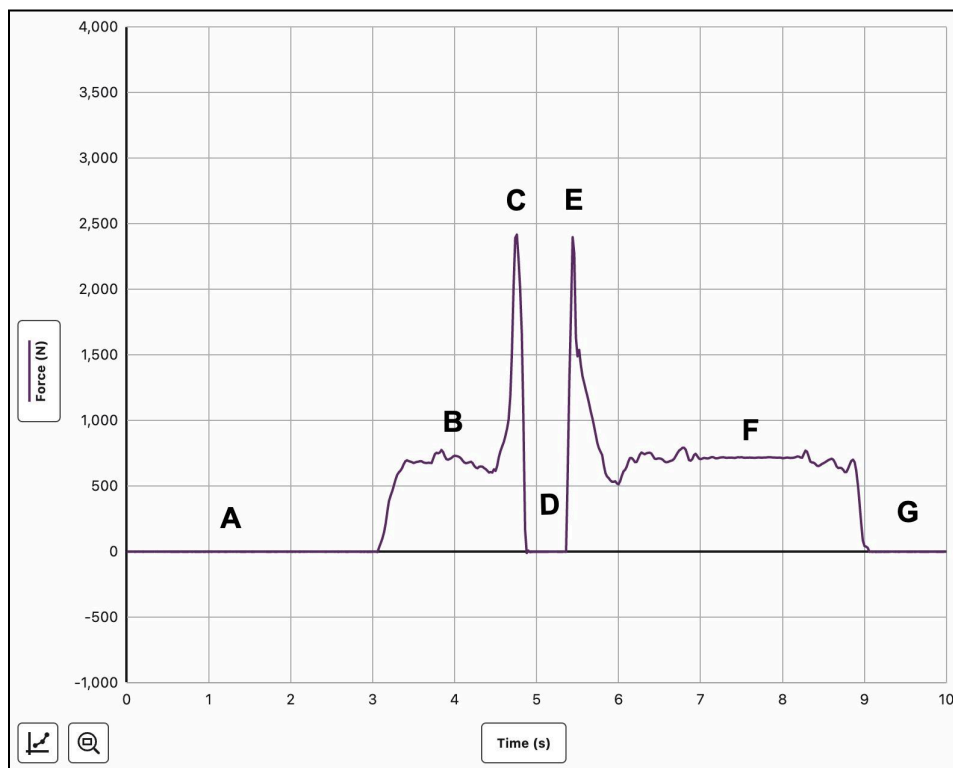
A stopwatch is one tool for measuring time (Figure 2). The start and stop times are only accurate to within  $\pm 0.2$  s because of human reaction time.

Another tool to measure time is a force plate (Figure 3). A force plate works much like a bathroom scale. It collects force and time data so you can observe changes in the force that is applied to the plate. The default sampling rate for the Vernier Go Direct Force Plate is 50 samples/s. Or to put it another way, the time between samples is 0.02 s.

4. Reflecting on the information above, provide two reasons why you would want to use one tool over another for measuring hang time.

5. Examine the following force vs. time graph of someone jumping on a force plate.

When data collection started, the jumper was standing on the ground. During the data-collection period, the jumper stepped onto the force plate, jumped, landed on the force plate, and then stepped off the force plate.



6. What is happening in each section on the graph? Fill in the blanks below to identify the jumper's action in the sections labeled A–G.

**Note:** Some actions, such as standing on the floor, happen more than once.

A	<b>Jumper Action</b> <b>(some actions are repeated)</b>
B	
C	
D	
E	
F	
G	

# Objectives

- Conduct an investigation to measure hang time accurately.
- Analyze and interpret a force vs. time graph to identify patterns of motion.
- Use digital tools to determine the maximum height of a vertical jump from the hang time.

## Materials

- ☐ Go Direct Force Plate (GDX-FP)

## Investigation

### Collect force data and determine hang time

1. Set the force plate on the floor. Make sure there is enough room so that the jumper can stand on the floor next to the force plate, step on the force plate, jump, land safely on the force plate, and step off.
2. Launch Graphical Analysis and connect your force plate via Bluetooth® wireless technology or USB.

If using Bluetooth, follow these steps:

- a. Click Sensor Data Collection.
- b. Find your force plate in the list of available devices and click Connect.

**Tips:**

- The ID is located on the label of your force plate.
- Ensure the force plate is powered on (red blinking LED) and that Bluetooth is enabled on your device.

- c. Click Done.

3. Read through the data-collection procedure to become familiar with the steps, and then collect data for 1 jumper.


#### **Data-collection procedure**

1. Start data collection.
2. The jumper steps onto the force plate and balances on 2 feet.
3. The jumper jumps and then lands on the force plate.
4. The jumper steps off the force plate after landing.

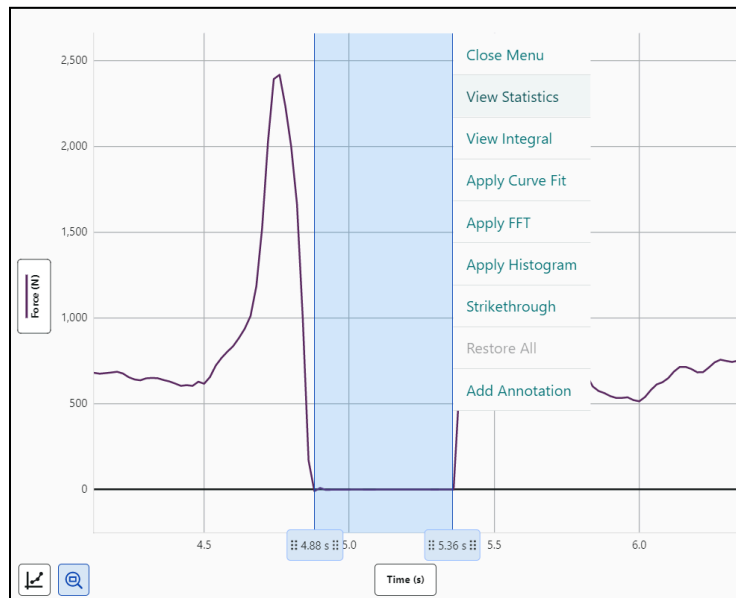
Data collection stops automatically after 10 s.

4. On your graph, identify when the jumper was in the air. How long was the hang time?

**Tip:** Graphical Analysis can help you determine the hang time:

- Select the data that represent when the jumper was in the air (Figure 4). If it is difficult to select the data you want, zoom in to a section of the data. To do this, select a region of the graph and then click Zoom to Selection, .
- With the hang time data selected, choose **View Statistics**.
- The  $\Delta x$  value is the duration of the selected region, the hang time. Record the value:



Hang time: \_\_\_\_\_



**Figure 4** Select data and use Statistics to determine hang time.

### Determine hang time a different way

To make the process of determining hang time even faster, Graphical Analysis has a built-in channel that automatically determines hang time for the jump.

- Turn on the Hang Time channel:
  - Click Sensor Setup, .
  - Click **Sensor Channels**.
  - Turn on the Hang Time channel. Leave the Force channel checked.
  - Click **Done**.
  - Use View Options, , turn on Meters.
- Collect data for another jump.

3. Record the hang time values using each method:
  - a. Use the statistics tool to determine the hang time and record the value in Table 1.
  - b. Record the value shown in the hang time meter.




Table 1	
Method	Hang time (s)
Statistics	
Hang time meter	

4. Compare the hang time value determined with the statistics tool to the hang time value shown in the meter. Were the two hang time values the same? If not, what might explain the differences? How does Graphical Analysis determine hang time?

## Determine jump height

During the Initial Ideas, you discussed ways of measuring the height of a jump. In addition to measuring directly, you can calculate the height based on the duration of the hang time. Graphical Analysis can also do this calculation for you.

Turn on the Jump Height channel:

- a. Click Sensor Setup, .
- b. Click **Sensor Channels**.
- c. Turn on the Jump Height channel. Leave the Hang Time and Force channels checked.
- d. Click **Done**.
- e. Click File, , and choose **New Experiment**. You do not need to save the file.
- f. Click **Sensor Data Collection**.
- g. Use View Options, , to turn on Meters.

## Competition time! Who can jump the highest?

1. Collect data for at least 5 people.
2. Record the hang time and jump height data for each jumper in the Summary Table.

Table 2: Summary Table		
Jumper	Hang time (s)	Jump height (m)
1		
2		
3		
4		
5		

## Analysis

1. What patterns do you notice between hang time and jump height? Can you identify a relationship between hang time and jump height? **Hint:** Create a manual entry graph in Graphical Analysis. Which measurement should be on the x-axis?
2. With a hang time of 0.92 s, Michael Jordan has a jump height of 1.04 m! Who in your group came closest to Michael Jordan's jump height?
3. What are ways that someone could increase their jump height?