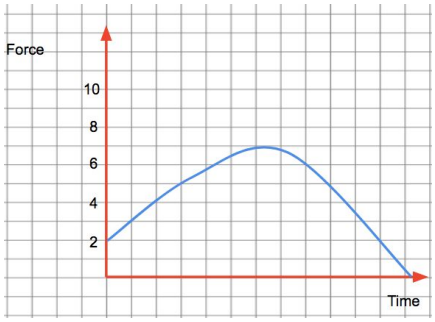
gROW TULSA

Pulling Together • Developing Understanding • Creating Opportunities

Investigating Force Curves version. 1.00



Introduction

In this lab activity you will learn about the force curve generated by the Concept 2 rowing machine PM Monitor. The monitor has the ability to measure the amount of force that a rower puts into the stroke over the duration of one stroke. The Force curve shows the units in Kgs on the Y Axis and time on the X axis. In essence, the curve starts at the beginning of the stroke and ends at the point the stroke has completed.

When the curve is analyzed it is possible to see the force applied on the hand at a particular time during the stroke. The area under the curve represents impulse and therefore work done during each stroke.

In this activity you will investigate different force curves and perform analysis on each curve. You will calculate the area under the curve using a technique based on finding the area of a trapezoid. This method will give you a reasonably accurate measurement of area under the curve so that you can evaluate the effectiveness of each rower. Finally, you will have the chance to analyze your own curve and assess how you can improve it.

In general, the smoother the curve is the smoother the application of force (ideal). In addition, the larger the area under the curve, the larger the amount of force applied per stroke.

Pre-Activity

Before doing this activity, you should experiment with the force curve on a Concept2 Rowing Machine so that you understand how the curves are generated and what they mean. You will have the chance to analyze your own force curve later on in this activity.

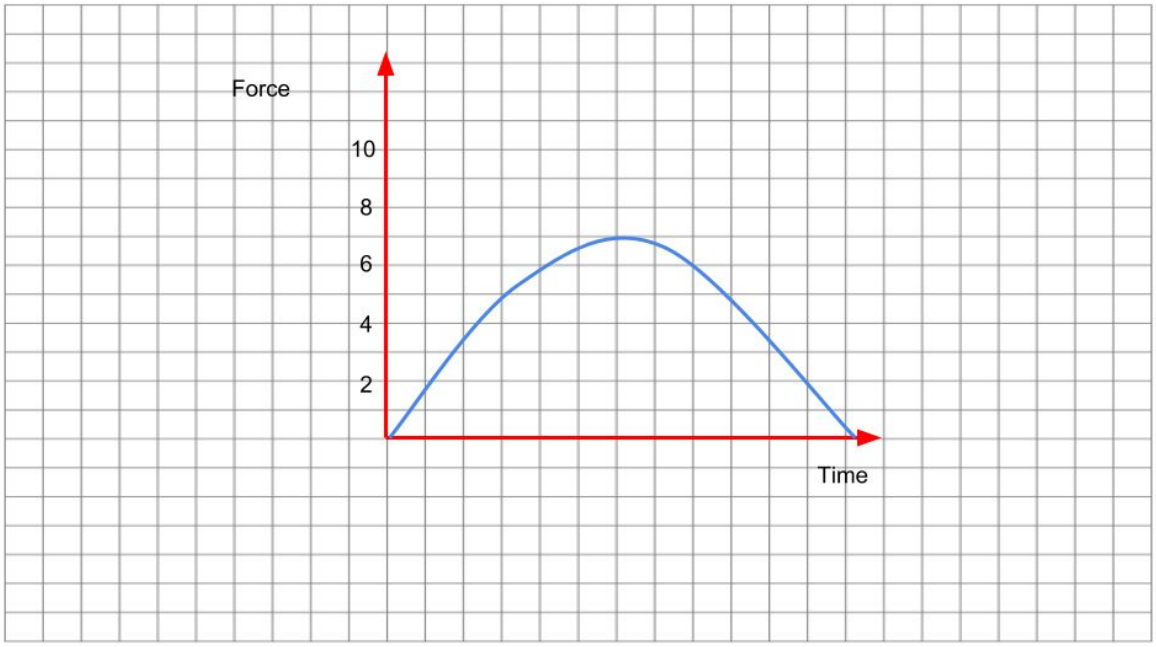
How To Access The Force Curve on The Concept2 Ergometer

The PM3, PM4 and PM5 monitor all provide a force curve utility. Press the Change Display or Display button on the monitor to access the curve function.

Task 1:

The graph below represents a stroke pulled by rower A. Each square represents 0.1s of duration.

Label the x axis with the time and include the units.



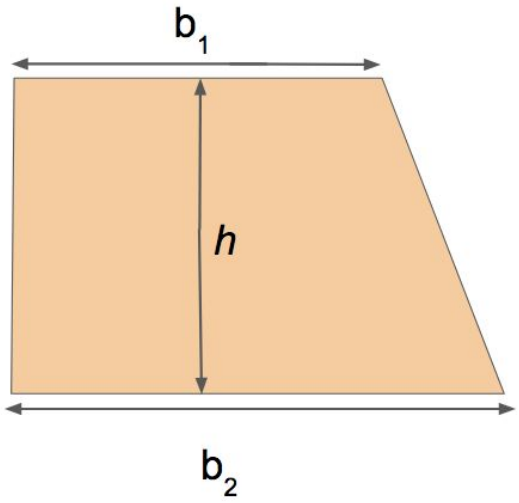
1.Describe the graph in your own words. Is it consistent? What kind of shape is it?

2. How much time does it take this rower to reach the maximum amount of force in this stroke?

3. What is the maximum amount of force pulled in this stroke?

4. Calculate the area under the curve by spitting the curve into trapezoid segments. Measure the length of both sides and the height of each trapezoid there is a picture provided to show you how this can be accomplished. Use the following formula.

$$\frac{1}{2} h * (b_1 + b_2)$$

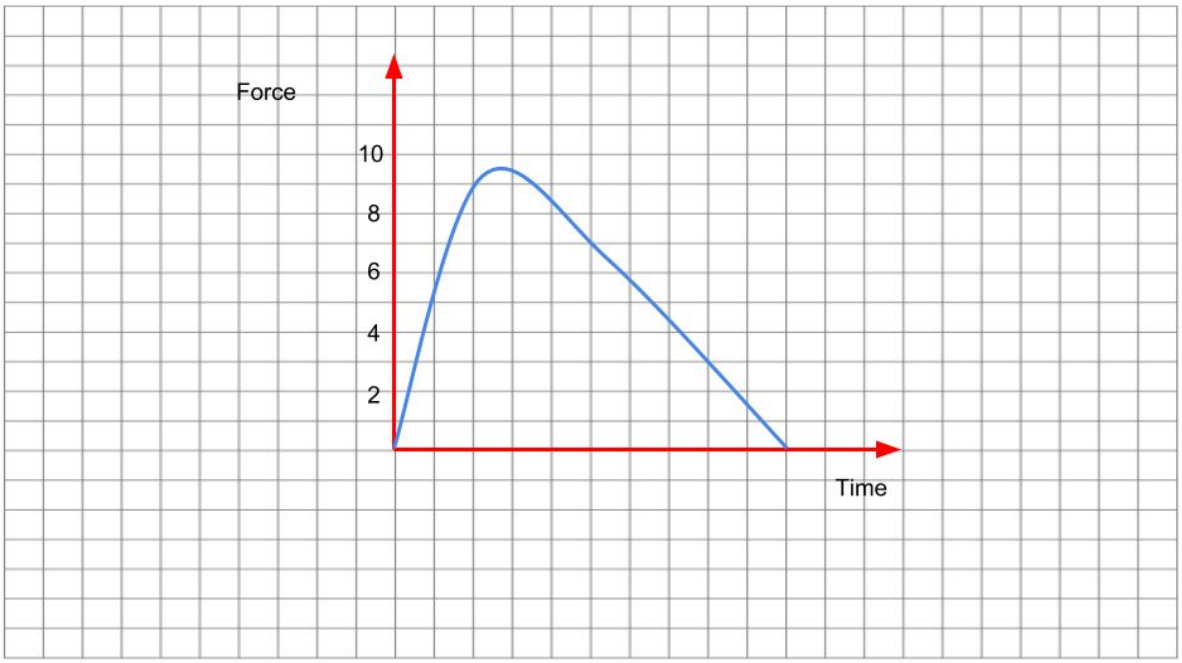


Force Curve of Rower A Broken Into Several Trapezoids

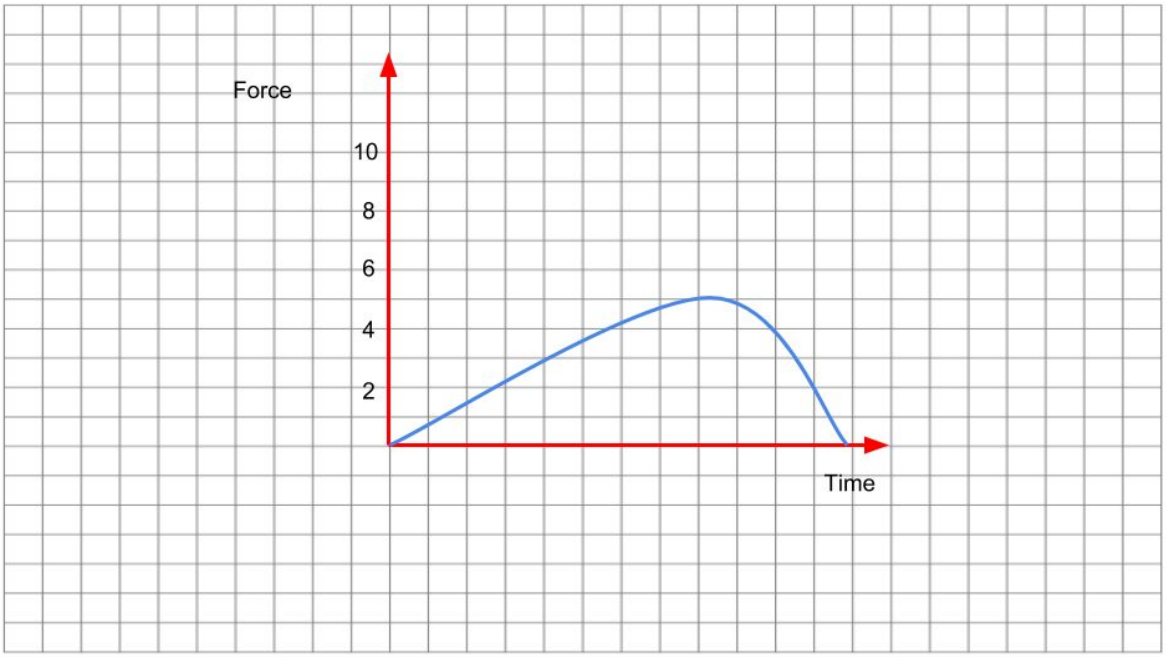
Task 2:

Using the same method that you used to calculate the area under the curve for rower A, calculate the area under the curve for rower B and C.

Rower B Force Curve



Rower C Force Curve



Data Table

Force Curve	Area Under The Curve (cm^2)
A	

B	
C	

Analysis

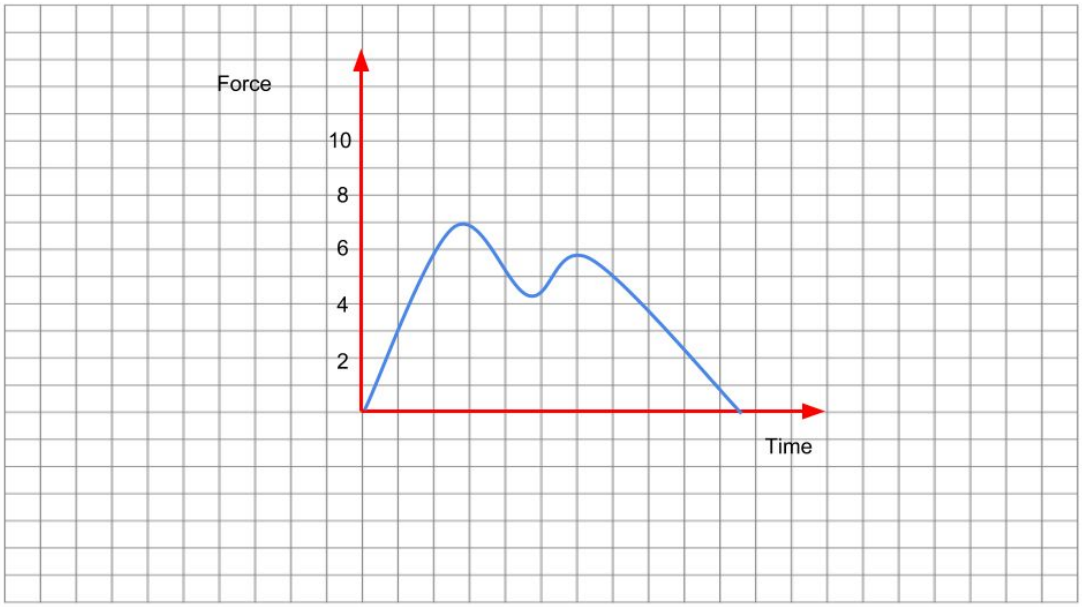
1. Which of the three curves (Rower A, Rower B or Rower C) had the greatest area under the curve?

2. Which rower would travel the furthest in the stroke graphed based on your answer to question 1?

3. What advice would you give to someone learning how to row for the first time given what you know now?

Task 3: Further Analysis

Analyze the curve shown below and then answer the questions that follow:



1. What is different about this curve compared to the force curves of Rower A, B and C?

2. What is the area under the curve for this force curve? (Use the trapezoid method you developed in the first part of this activity).

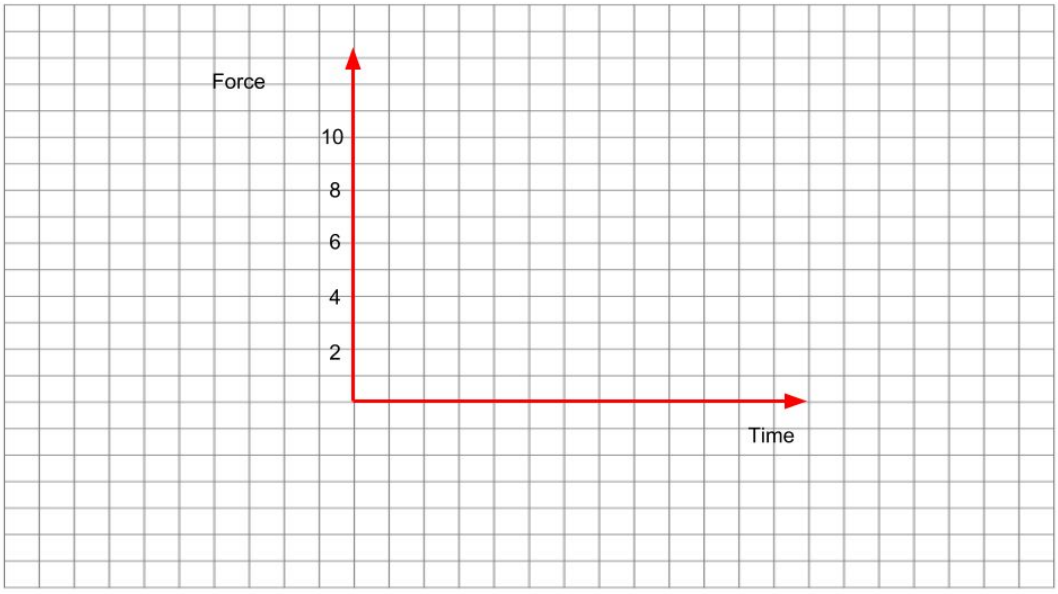
3. A. How does the area under this curve compare to the areas for Rower A, B and C?

4. What do you think caused the parts of the curve that feature a loss in power application? Can you suggest a strategy that you could tell this rower to fix the loss of power?

5. Can you calculate the approximate amount of power that this rower has lost because of your answer to question 4?

Your Turn

Use the Concept 2 rowing machine to generate your own force curves. Experiment with your technique to generate the most area under your force curve. When you have finished experimenting, sketch your curve on the pair of axes below.



Analysis

1. Calculate the area under your curve using the trapezoidal method.

2. How does your curve are compare to the other examples presented in this activity in terms of shape and area under the curve?

3. How could you improve the shape of your curve and therefore power application each stroke?

Optional Lab Extension

Write a program using a coding language of your choice to help you calculate the area of each trapezoid.

You could choose the following methods:

1. Use a calculator and research how to program the calculator to perform the calculation.
2. Write a web-based program that uses Python, PHP, C#, Javascript, JQuery to help you perform the calculation.