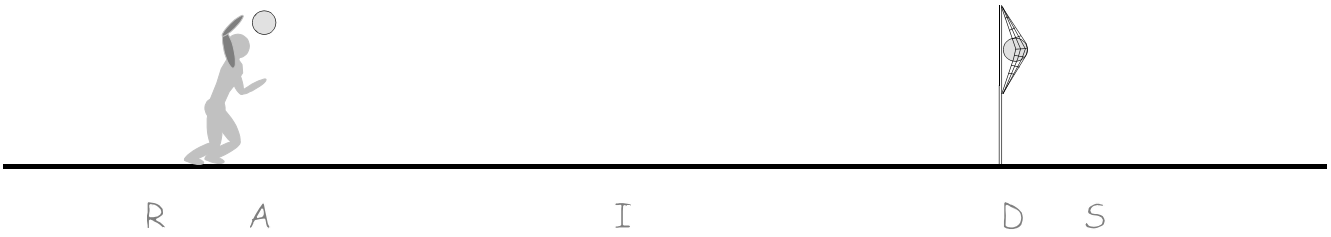
Volleyball Serve

It's your turn to serve on the volleyball court. You wind up and give the ball your best shot. You watch it spin too low and into the net! Let's try it, and then analyze the motion of the volley ball.



Rest	the ball is nearly at rest, just before being hit by your hand.
Acceleration	during the collision with your hand, the ball speeds up toward the net.
Inertial Motion	the ball is in the air, at fastest speed, neither speeding up nor slowing down.
Deceleration	the ball hits the net, making it bulge (how far?). It slows and stops.
Stop	the ball has stopped moving, and has velocity of zero again.

1. **Read over the whole lab exercise**. Decide what you are trying to find out.

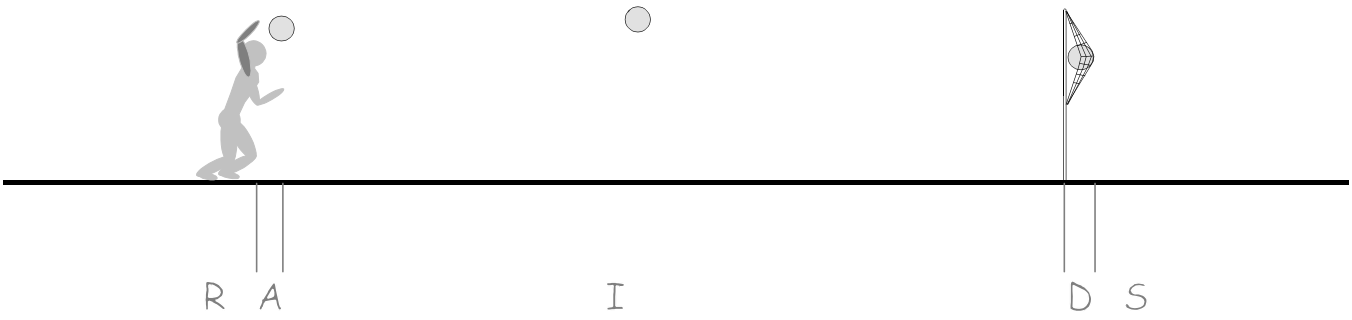
2. **Plan your measurements.** Practice a few times. How will you make the measurements that you need? Write your plans here.

Things you need to know:

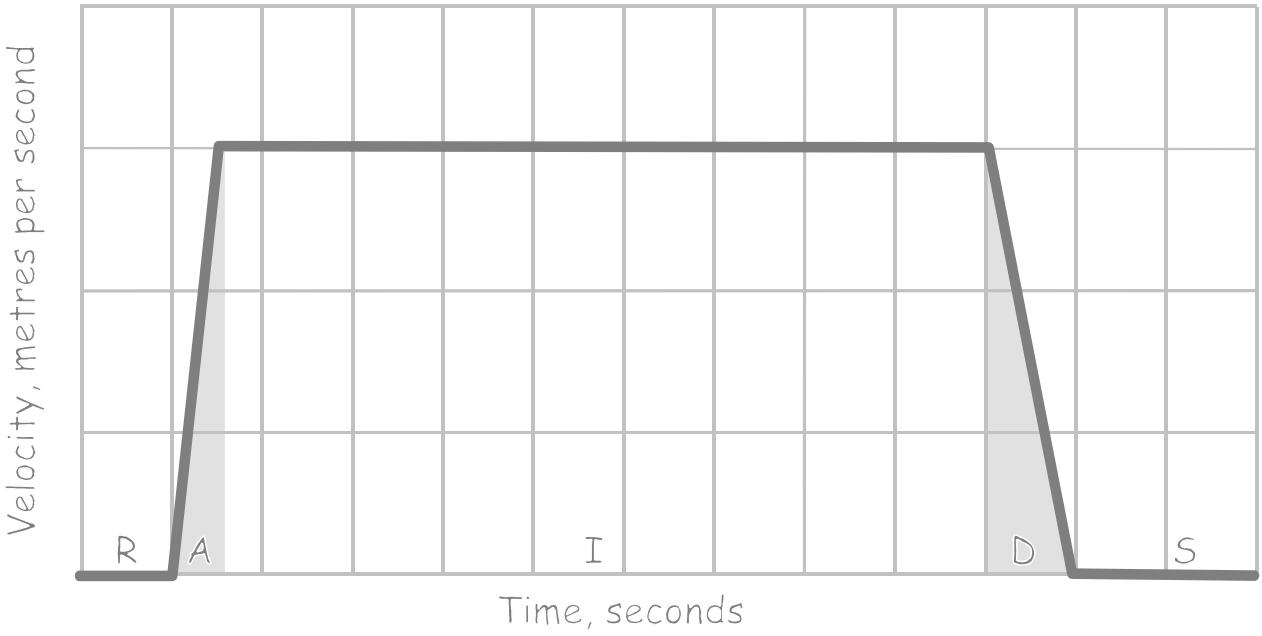
2 Collect Data
Sketch v:t graph

Volleyball Serve

1. **Make the measurements** on the your volleyball serve. Record the **m**ass of the ball, and all of your **t**ime and **d**istance measurements on the diagram below.



2. **Print your time measurements** on the v:t graph below. (not to scale)

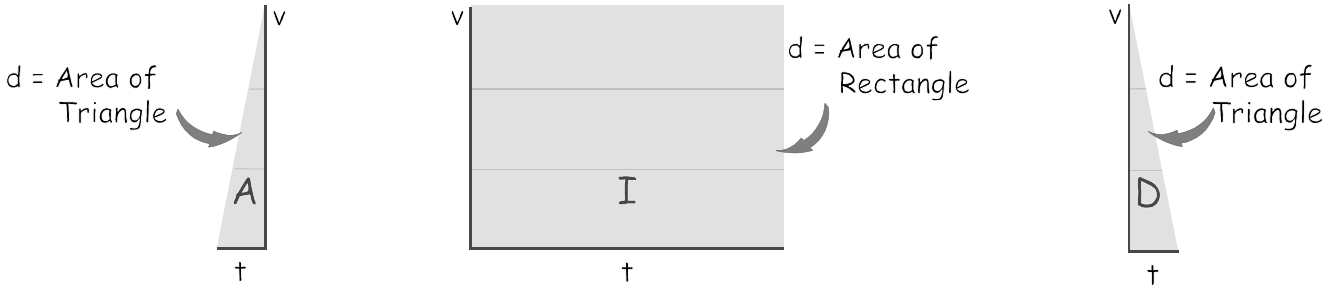


3. **Calculate the volleyball's maximum speed** and print that on the v:t graph above.

3 Adjust your v:t graph
Make **d**, **t** and **v** agree!!

Volleyball Serve

1. **The area under a v:t graph is the distance traveled in that part of the graph!!** Calculate the time **t**, the displacement **d** and the greatest velocity **v** for each section of the graph.



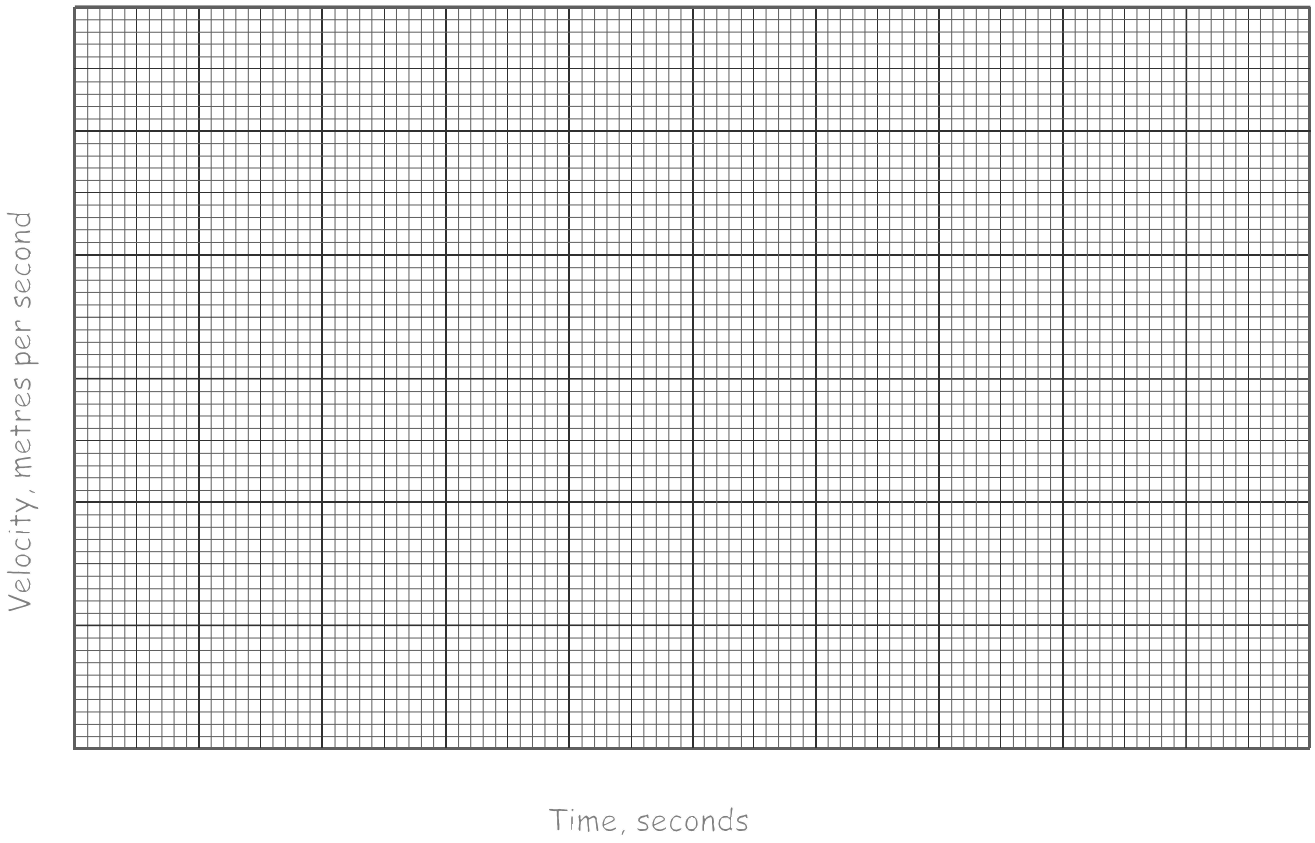
t_a= _____ t_i= _____ t_d= _____

d_a= _____ d_i= _____ d_d= _____

v_a= _____ v_i= _____ v_d= _____

Note: Since The *R* and *S* sections of the graph have v = 0, and d = 0, we will only work on the *A*, *I* and *D* sections.

2. **Compare the velocities** of each section of the graph. The maximum velocity should be the same.
3. **Compare the displacements.** The three sections should add up to your total measurements.
4. **Compare the times.** The times in the three sections should add up to your measured total times.
5. **Make changes to your graphs** to make a closer fit to your measurements.
6. **Sketch a new v:t graph** with all of your changes.

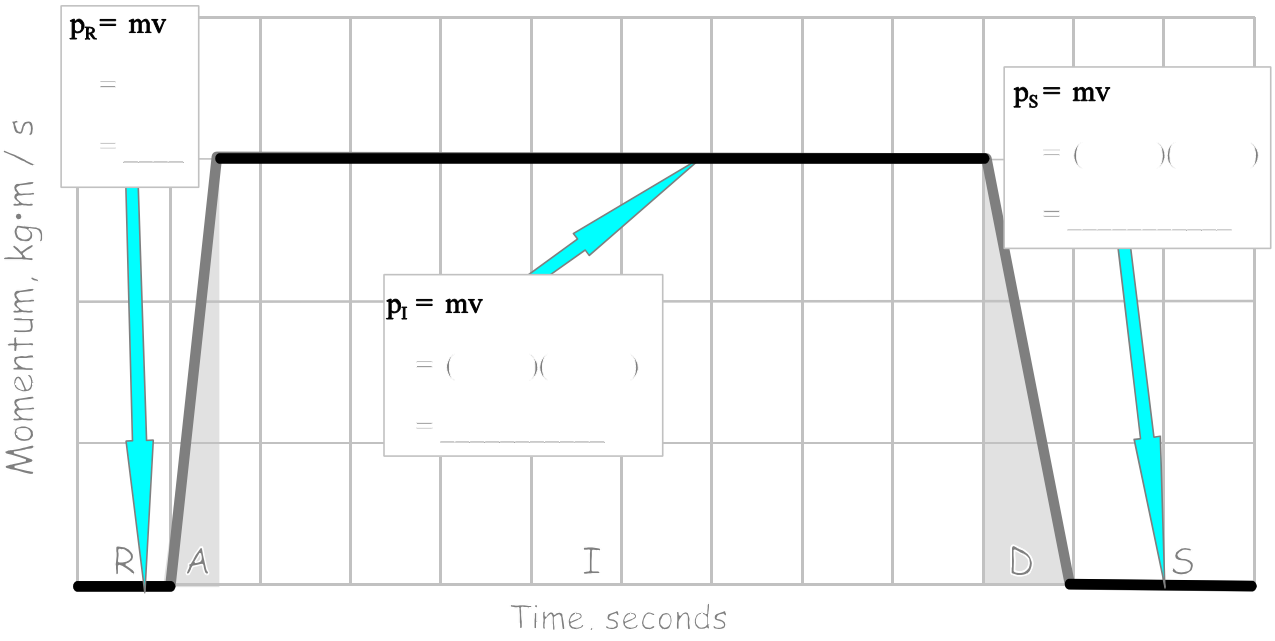


4 Sketch New Momentum : time graph

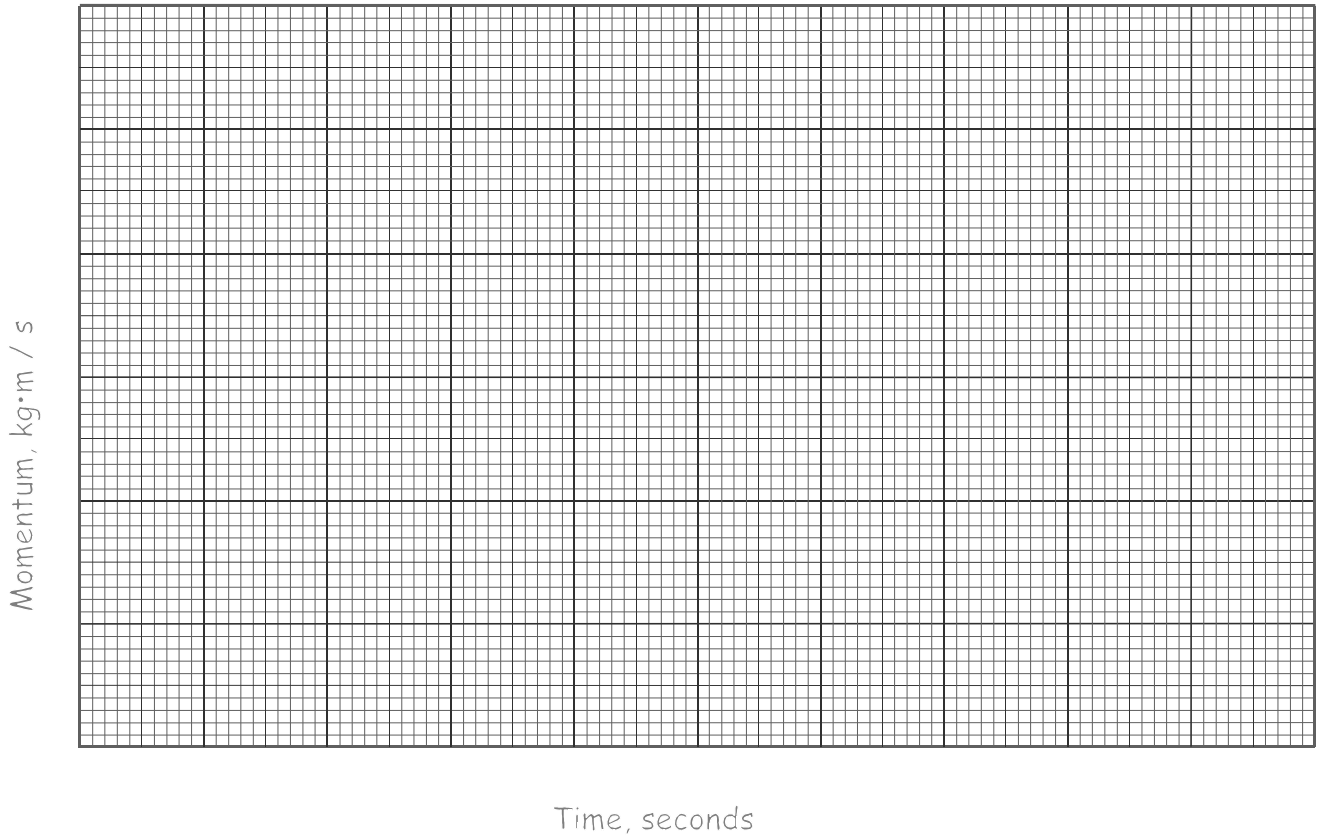
Volleyball Serve

Momentum is "mass in motion." It is easily calculated by multiplying the mass of the volleyball by the velocity of the volleyball. The ball is not very massive, but it does travel at a high rate of speed. Of course, when the volleyball has no velocity, it has no momentum.

1. **Calculate the momentum at R, I and S.** Remember... Momentum $p = mv$



2. **Sketch a new p:t graph** with the same time scale as your v:t graph on pg 3.



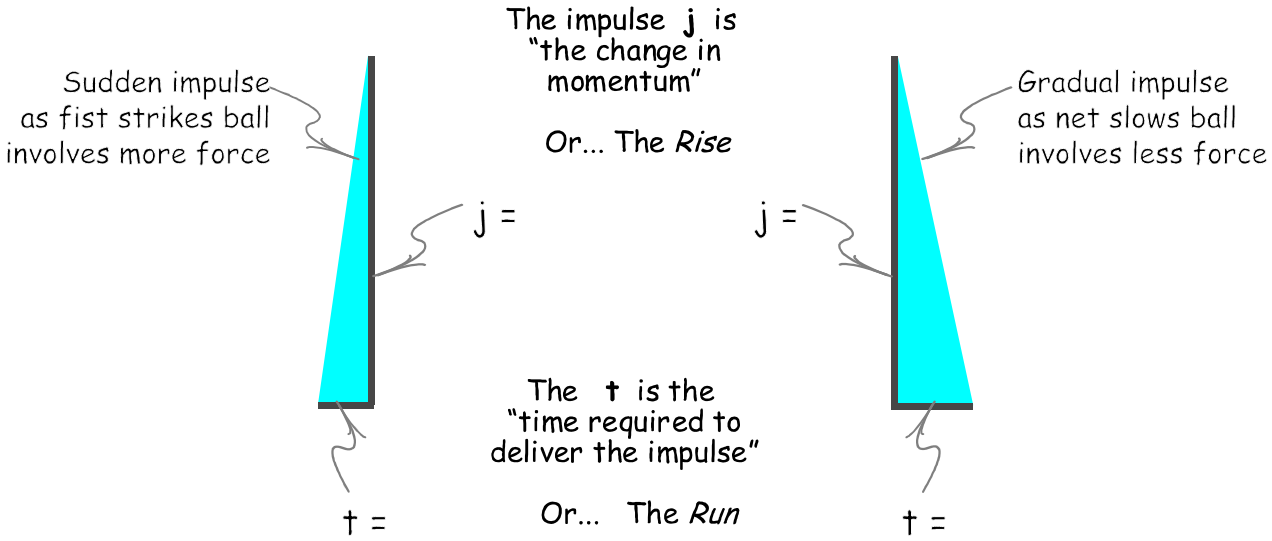
5 Find Impulse j and Force F

Volleyball Serve

Impulse **j** is the "jolt" or the "oomph" that is given to any object when it changes its velocity. Your hand provides the "oomph" that gives the ball its momentum. The net provides the "oomph" in the opposite direction that takes the momentum away. On your *momentum : time* graph, the impulse **j** is the *height* of the triangle, or the *rise* of the triangle.

The time taken to deliver the "jolt" or "oomph" on your *momentum : time* graph is **t**.

3. **Find the impulse j and the time t** for the volleyball serve and mark them on the graph below.



An impulse always involves a force. The sudden change in momentum caused by your fist involves more force. The slower change in momentum caused by the net involves less force. The size of the force can be found by the equation $F = j \div t$.

4. **Find the Force that was exerted.**

Force as fist strikes volleyball

$j = (\_\_\_\_\_)$

$t = (\_\_\_\_\_)$

$F = \frac{j}{t}$

$= \frac{(\_\_\_\_\_)}{(\_\_\_\_\_)}$

$=$

Force as net slows the volleyball

$j = (\_\_\_\_\_)$

$t = (\_\_\_\_\_)$

$F = \frac{j}{t}$

$= \frac{(\_\_\_\_\_)}{(\_\_\_\_\_)}$

$=$

Volleyball Serve