Golf Putt

This is a skill that even mini-putt golfers need to learn. You are going to putt the ball, and you must get it to stop within a circle painted on the grass. Let's try it, and then analyze the motion of the golf ball..

Rest	the golf ball is at rest, with a velocity of zero.
Acceleration	in a very short time, the ball is given a "putt" that accelerates it.
Inertial Motion	not part of this motion at all. The golf ball begins to decelerate immediately.
Deceleration	the golf ball slows down gradually as it rolls over the short grass.
Stop	the golf 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.

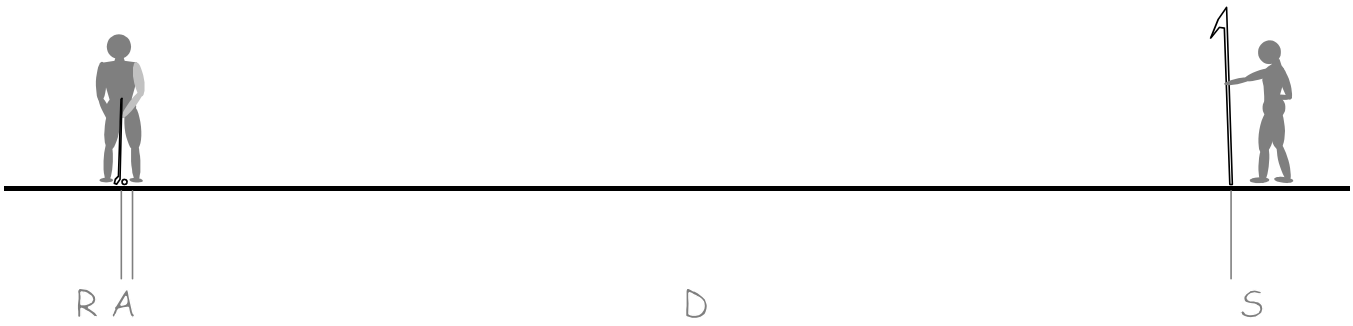
2. **Plan your measurements.** Practice a few times. How will you make the measurements that you need? Write your plans here.

Things you need to know:

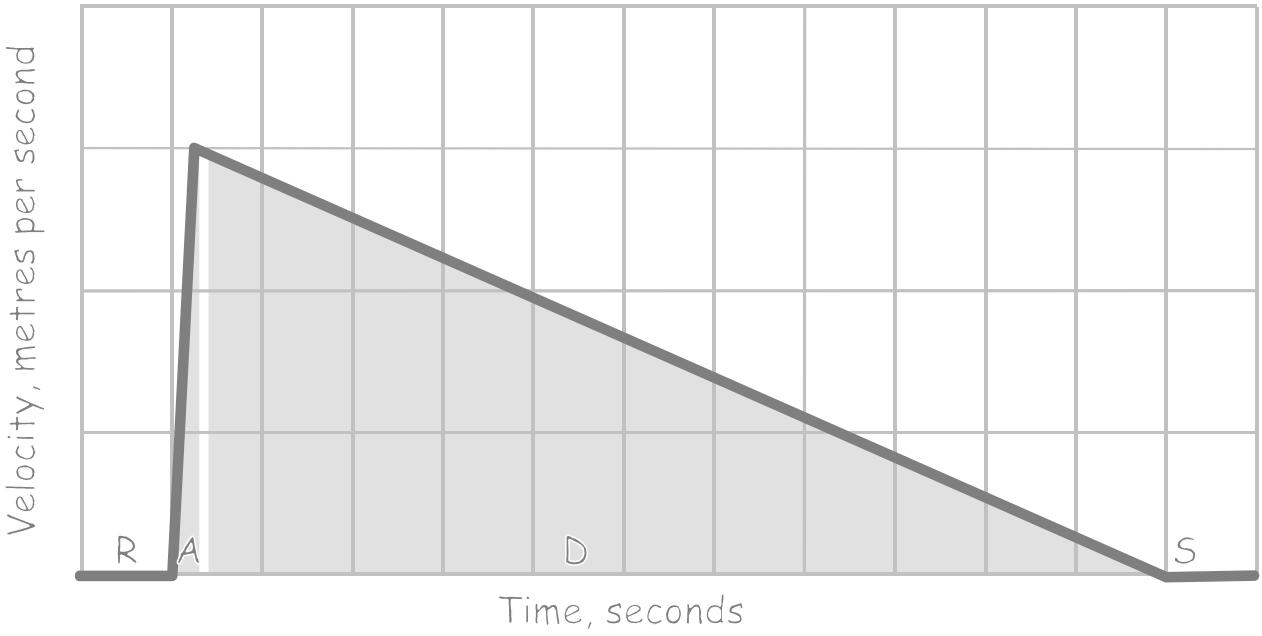
2 Collect Data
Sketch v:t graph

Golf Putt

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



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

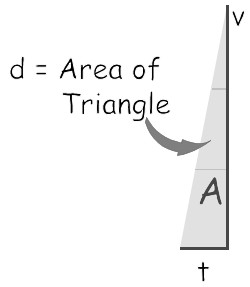


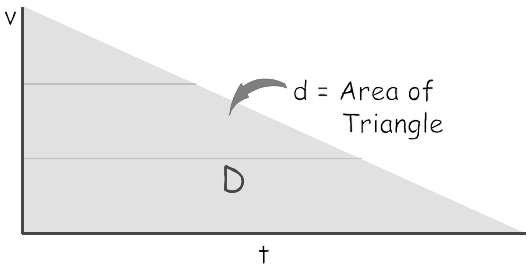
3. **Calculate the maximum speed of the golf ball** and print that on the v:t graph above. Note that the golf ball begins to decelerate the instant that it reaches v_{max}. There is no "constant velocity" segment in this motion.

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

Golf Putt

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. Note that ball accelerates for a very short time. The golf ball decelerates for nearly the entire motion, until it comes to rest.



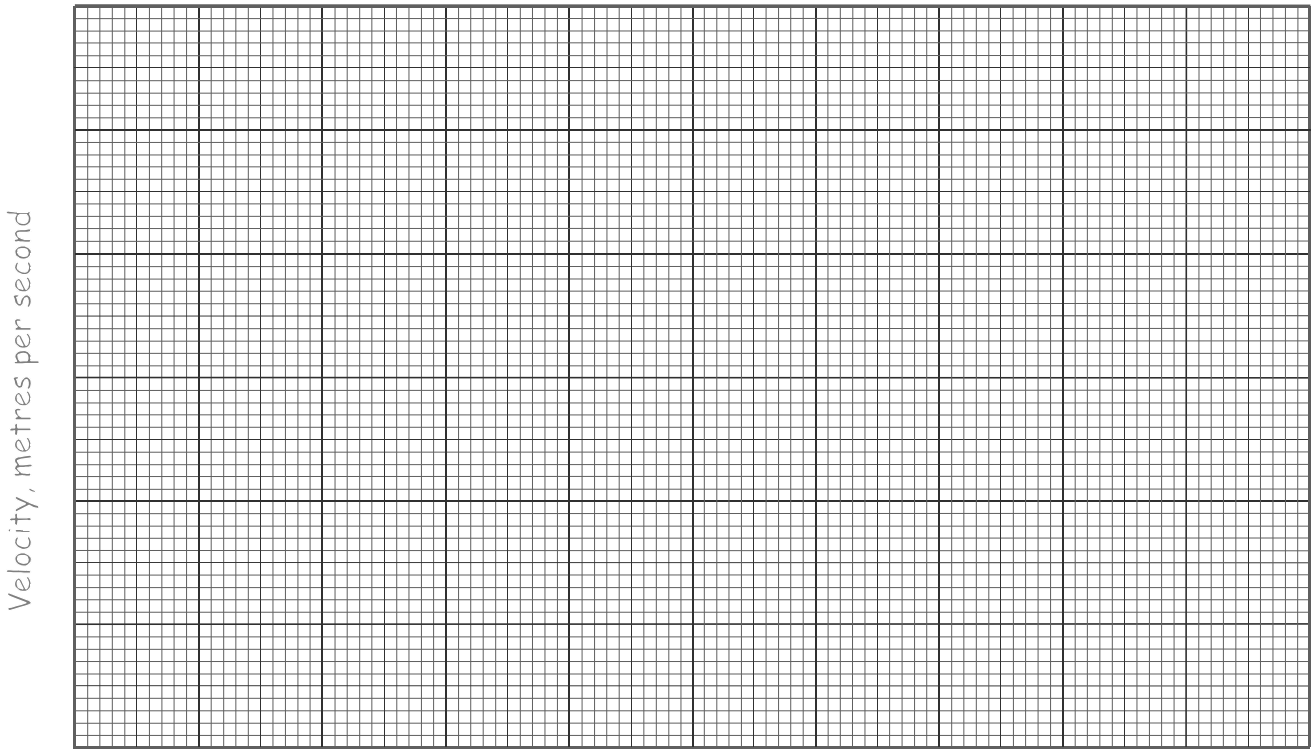


t_a= _____ t_d= _____

d_a= _____ d_d= _____

v_a= _____ v_d= _____

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.

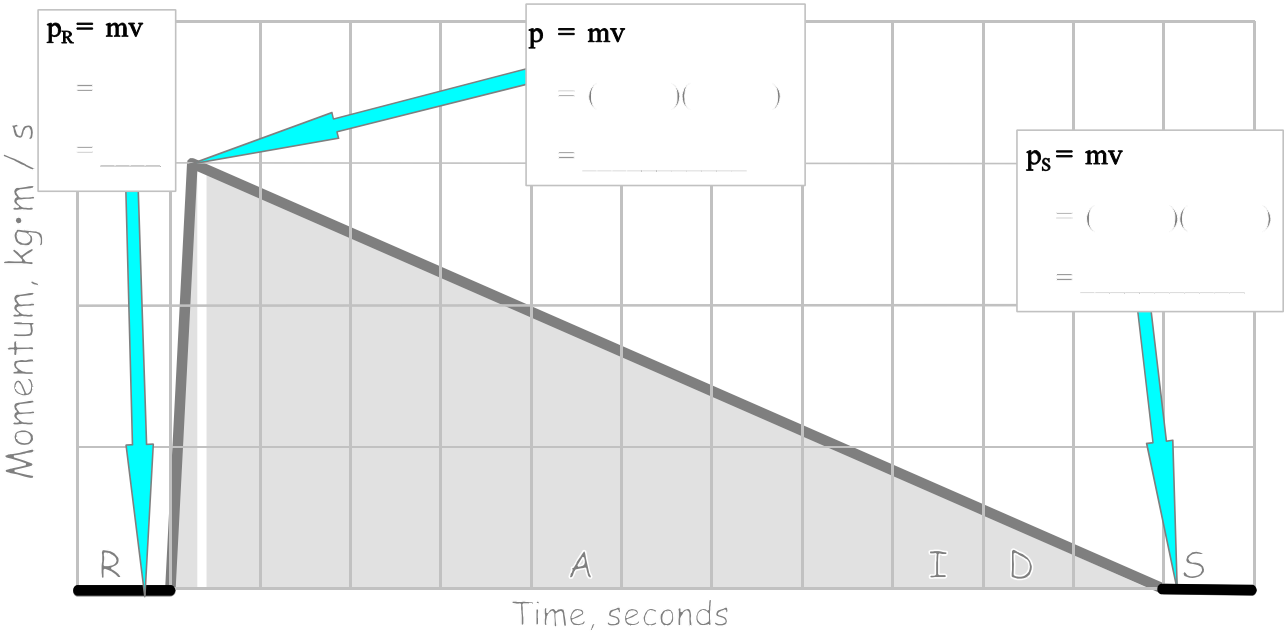


4 Sketch New Momentum : time graph

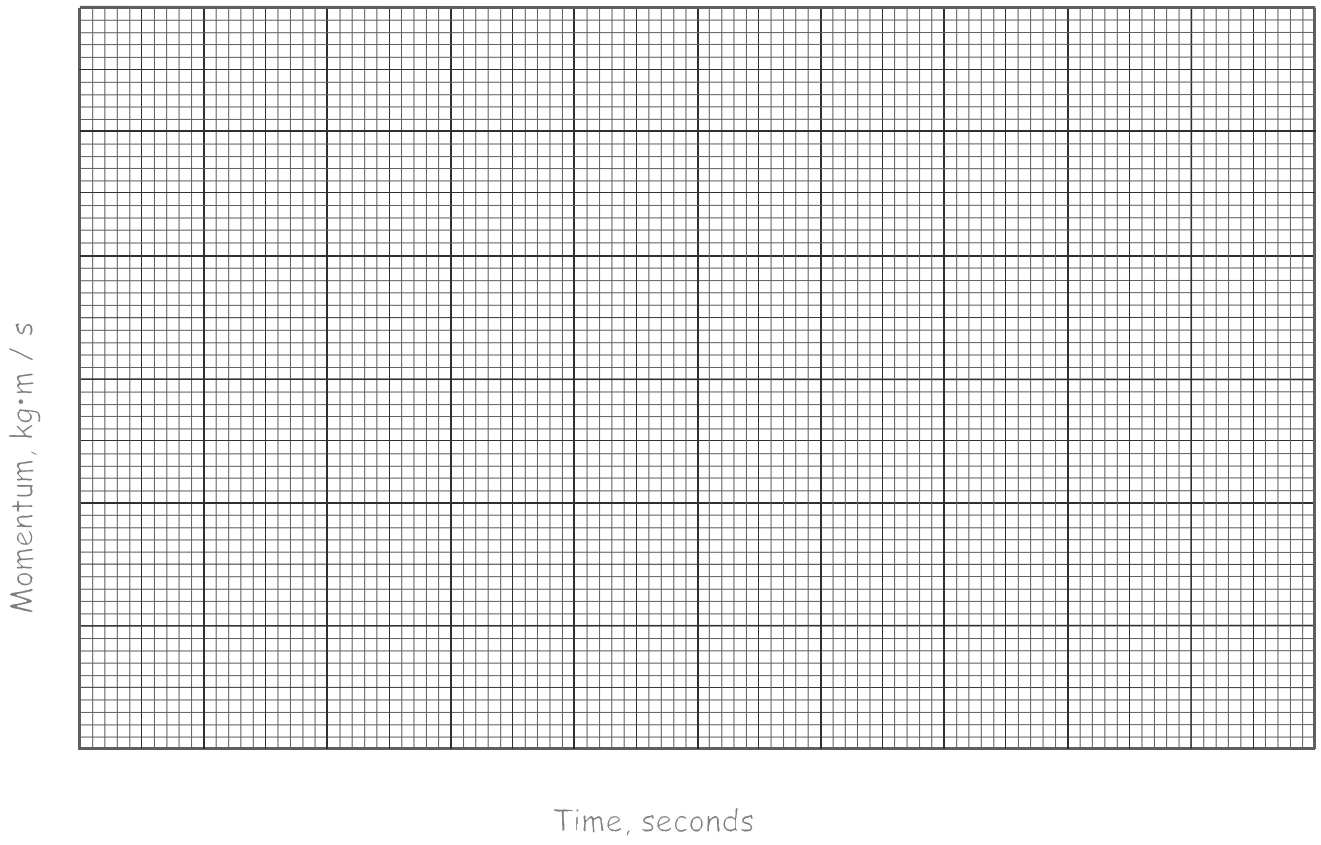
Golf Putt

Momentum is "mass in motion." It is easily found by multiplying the mass of the golf ball by the maximum velocity of the golf ball. The small mass and small velocity of the putt means that the momentum is also quite small.

1. **Calculate the momentum at R, v_{max} 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

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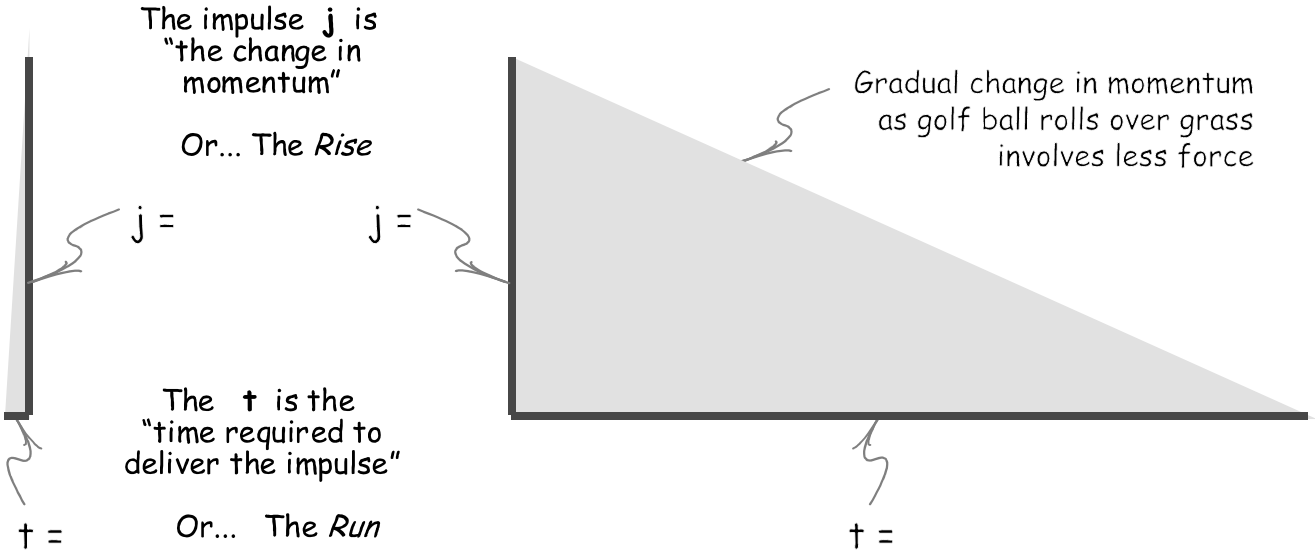
Impulse **j** is the "jolt" or the "oomph" that is given to any object when it changes its velocity. The impulse is the "change in momentum." On your *momentum : time* graph, the impulse **j** is the *height* of the triangle, or the *rise* of the triangle.

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 golf putt and mark them on the graph below.

An impulse always involves a force. The sudden change in momentum when the putter hits the ball involves greater force. The gradual change in momentum when the ball rolls over the grass 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 of the putter hitting the golf ball

$j = (\quad)$

$t = (\quad)$

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

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

$=$

Force of the grass stopping the golf ball

$j = (\quad)$

$t = (\quad)$

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

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

$=$

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