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CASIO

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Using graphical calculators for teaching mechanics

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Velocity-time graphs

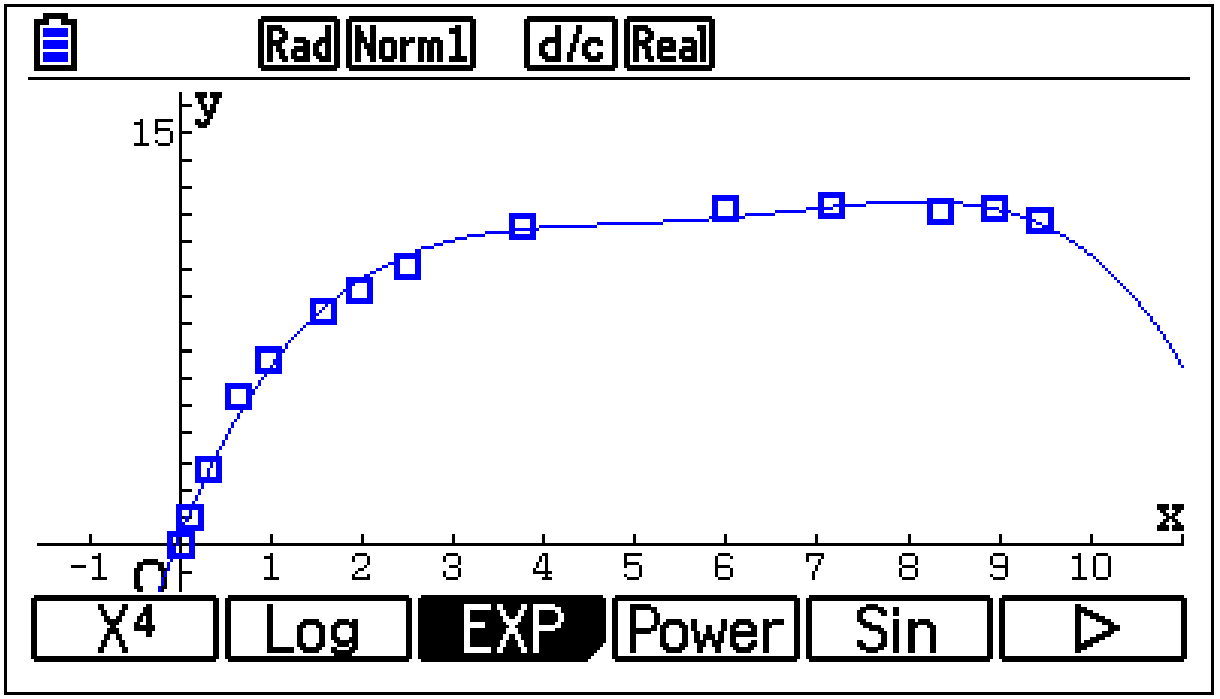
Usain Bolt's 100m world record

https://youtu.be/SyY7RgNLCUk

Menu 2 – Statistics
Enter time (list 1) and velocity (list 2)

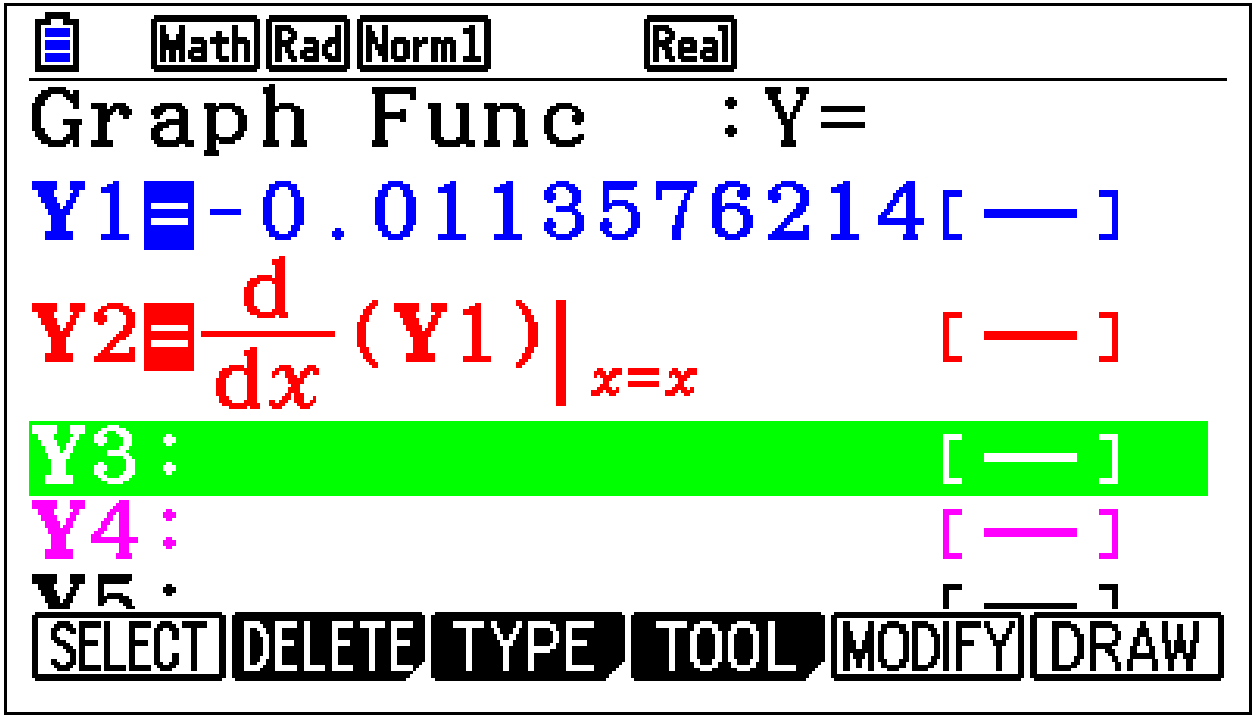
Time (s)	Velocity (ms^{-1})
0	0
0.10	0.94
0.29	2.74
0.63	5.39
0.96	6.68
1.57	8.46
1.94	9.28
2.50	10.14
3.76	11.52
5.98	12.17
7.16	12.29
8.36	12.06
8.95	12.20
9.44	11.80

note that 0.14s has been taken off of these times to help with modelling. What is represented by this time?



Displaying the data as a scatter graph, find a regression formula to model Usain Bolt's velocity over the 100m.

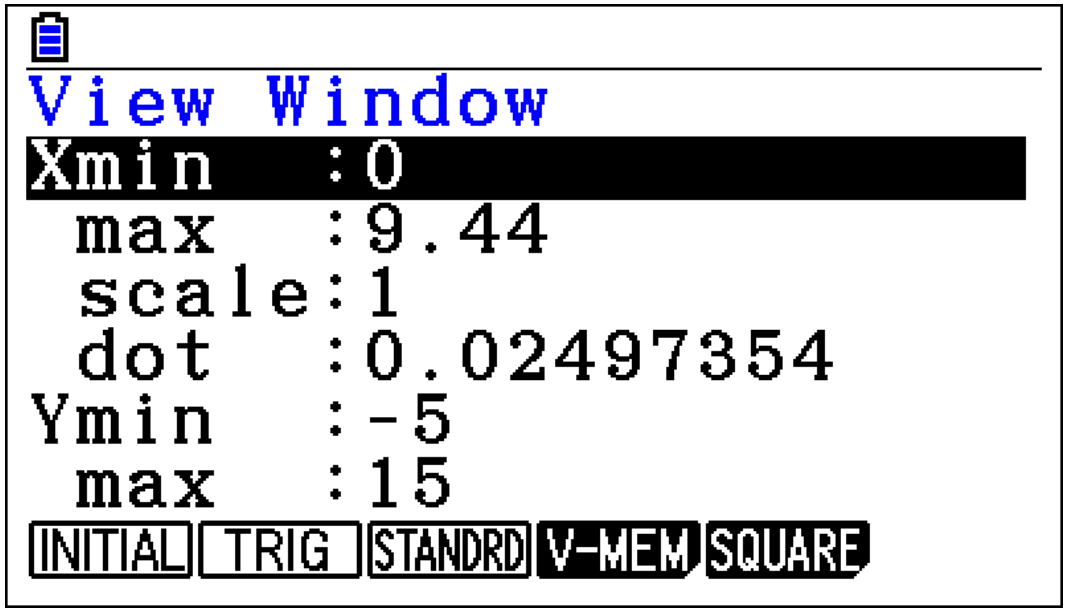
Then copy graph function and paste it into the graph menu.

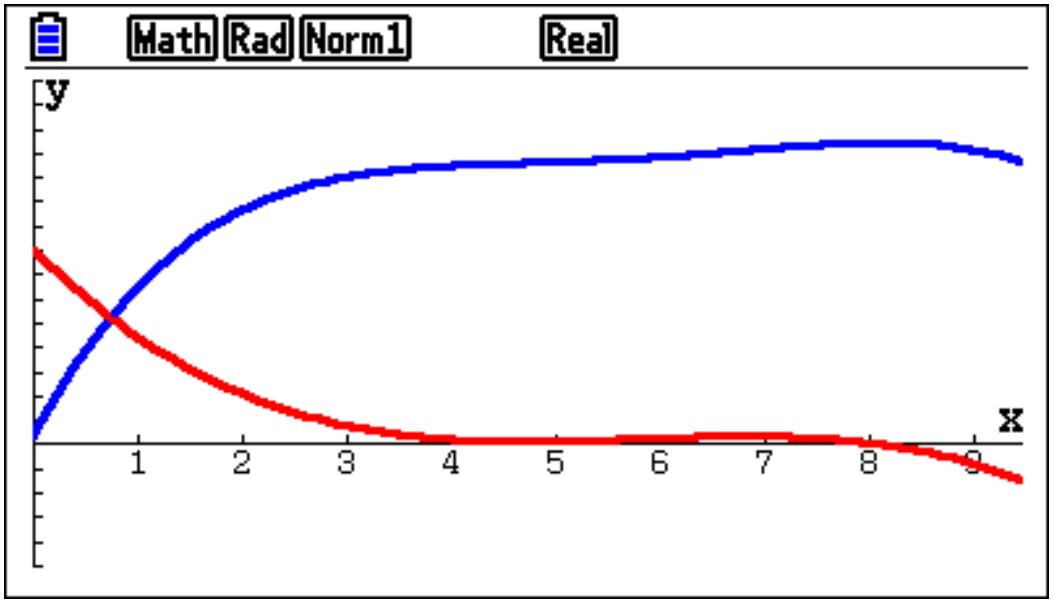


You can plot a graph of the derivative and this can be displayed simultaneously with your velocity function.

Set up the graphing option:

Menu 5 – Graph
Delete any graphs present F2, F1
Shift/menu to enter SET UP - Turn Simul Graph on
Shift/F3 to View Window



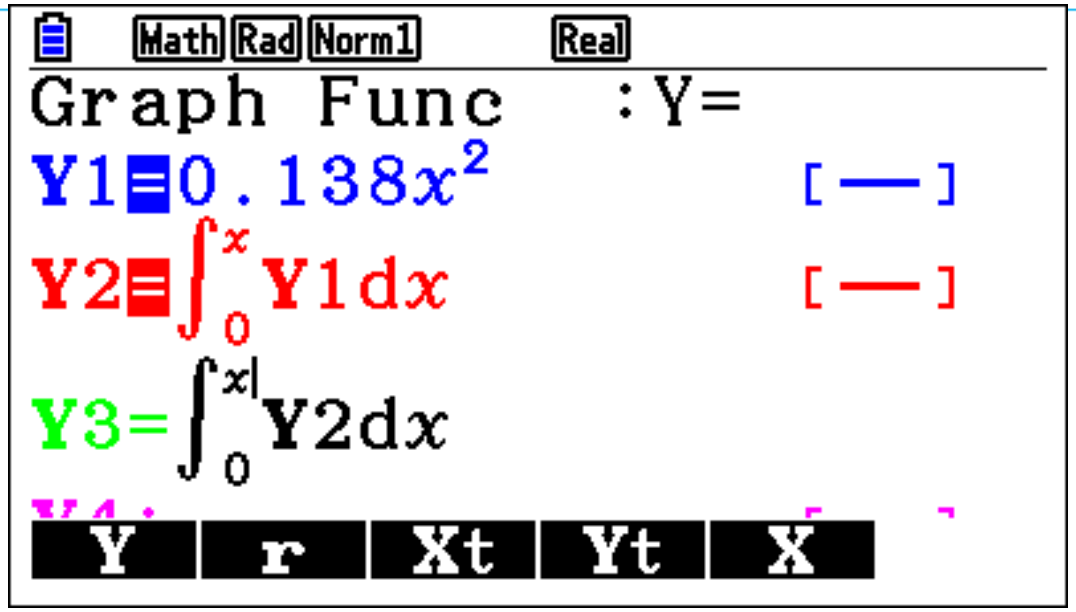


Use the calculator to find:
total distance travelled
maximum velocity
maximum acceleration
maximum resultant force in both directions
(what extra measurement do we need to do this?)

Resources available here:
http://mei.org.uk/casio-tasks

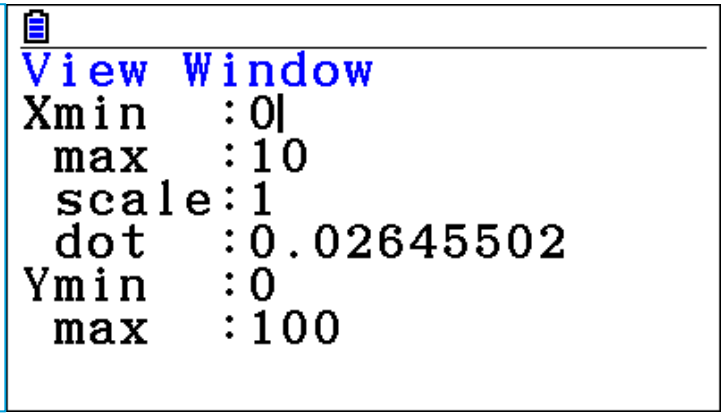
Additional questions for Task 1

- At what time does the particle change direction and which graphs can you use to find this?
- How far does the particle travel before changing direction?
- How can you find the total distance travelled after the particle has changed direction?

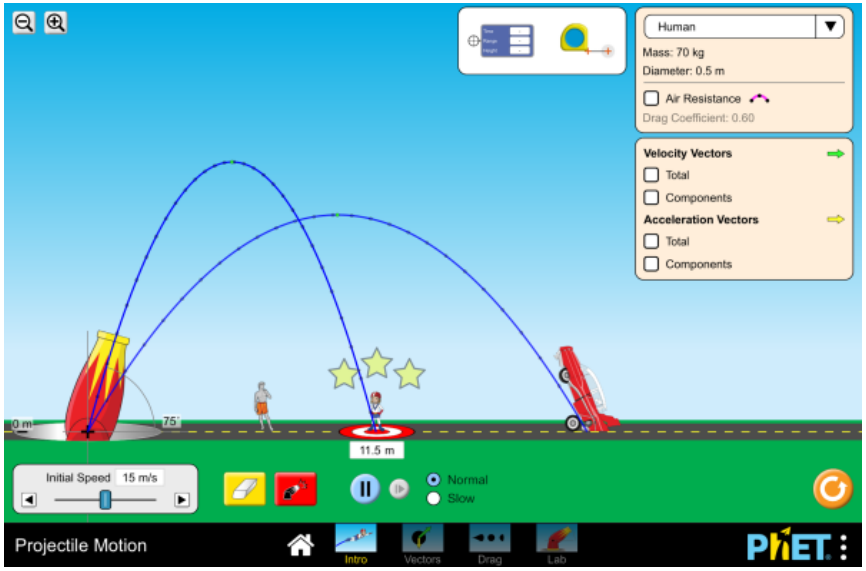


It is also possible to plot the integral of a function.

The first function is modelling the displacement of a minibus as it travels 100m.



Projectiles



- Use Phet simulations to collect data

https://phet.colorado.edu/en/simulation/projectile-motion

- Investigate parabolic functions on calculator

Resolving and adding vectors to calculate resultant

- Cut out vector arrows using a 1cm:1N scale
- Glue to poster in random directions
- Guess which poster has the largest resultant
- Use protractors to find direction of vectors

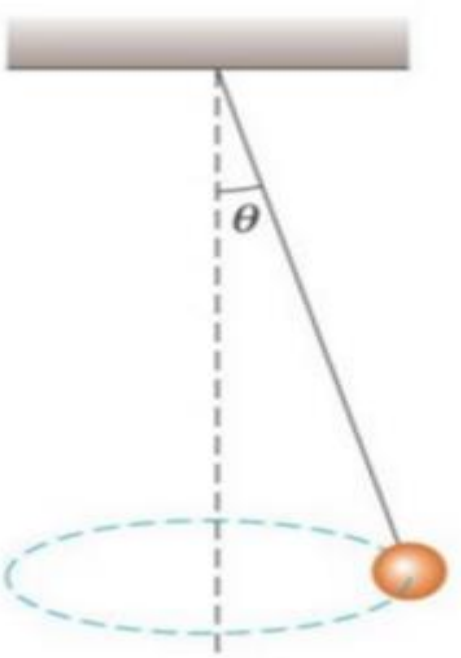
Resolving and adding vectors

- Menu 4 – Spreadsheet
- Enter magnitudes of vectors in column A
- Enter angles in column B
- Use = to enter a formula in a cell
- Select multiple cells using SHIFT/8 – CLIP then use FILL F2 F6 F1 to enter formula
- Use = F6 F6 to sum multiple cells using : between first and last cell
- Sum perpendicular components and then recombine to find resultant

Mechanics in Further Mathematics
Conical pendulum

- Attach fishing weight or bob to end of string
- Use timer (on phone) to time 10 oscillations with pendulum describing a horizontal circle with a diameter equal to a 30cm ruler
- Resolve forces vertically and radially to calculate *g*

$$\tan \emptyset = \frac{\omega^2}{g}$$



- Collect data from different groups using different length pendulums and use calculators to average results, or
- Write a program to calculate *g* after inputting time period