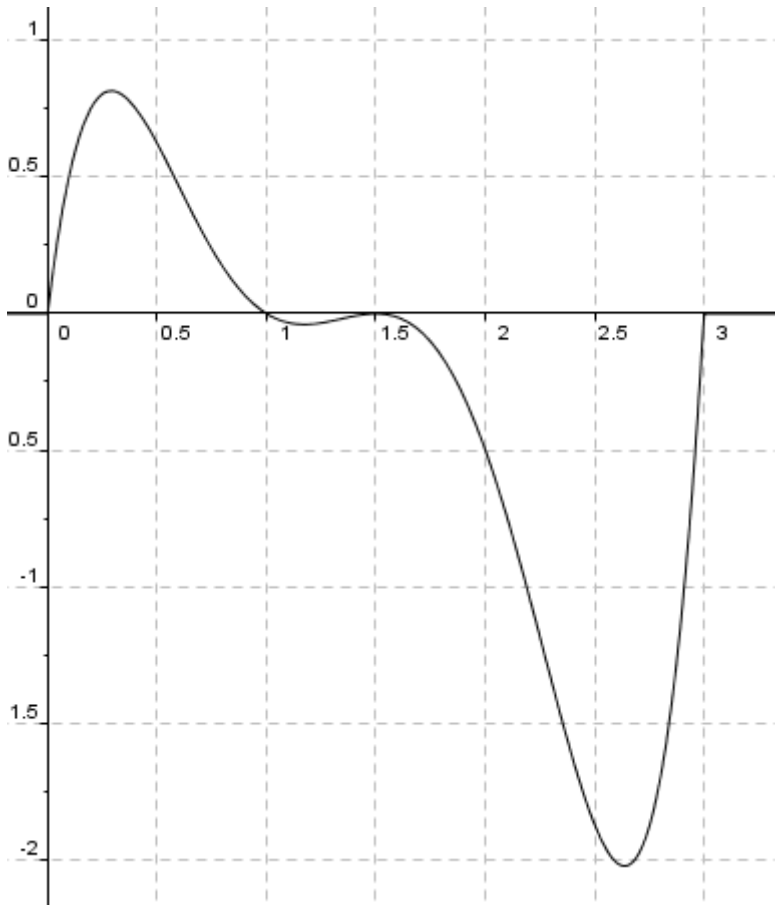
2015 SM2 Week 13 Investigation

Remember our Aztec Butterfly from mid-semester exam?

It used the following curve representing the distance from a flower that it travelled in the course of 3 minutes.



Distance in meters and time in minutes.

This is a displacement / time graph, with the following equation

$$D(t) = t(t-1)(t-1.5)^2(t-3)$$

a) Use technology to find the equation of the first, second and third derivative. Also use technology to sketch them.

Make sure your axis are labelled appropriately.

b) The following notes relate movement to the original function and the first, second and third derivative.

Displacement - a description of position in the case of our Butterfly, measured in m.

Velocity - the rate of change of displacement with respect to time (the derivative of displacement/time graph), in the case of our Butterfly, measured in m/min. It describes how the displacement changes, it is the speed of the butterfly. Positive velocity is moving away from the initial position, negative velocity is moving towards the initial position.

Acceleration - the rate of change of velocity with respect to time (the derivative of the velocity /time graph), in the case of our Butterfly, measured in m/min^2. It describes how the velocity changes. Positive acceleration will be speeding up, negative acceleration will be slowing down, it could be towards or away from the initial position.

Jerk - the rate of change of acceleration with respect to time (the derivative of the acceleration/time graph), in the case of our Butterfly, measure in m/min^3. It describes how the acceleration changes. This is important in engineering and manufacturing, an important consideration because a high jerk value means the acceleration has changed quickly affecting the force on a being. Too high a jerk can result in serious injury or death - an important consideration in rollercoaster's for example. A jerk value of 22 m/s^3 is considered a maximum safe value for humans. Note: a jerk value of 22 m/s^3 is a more severe than 22 m/min^3

Write 4 written statements, one for displacement, velocity, acceleration and jerk with regards to our butterfly that demonstrate your understanding of the 1st, 2nd and 3rd derivatives of displacement. Include some calculated values and relate these to relate to the context. Include a conversion into km/h for the maximum speed of the butterfly - do you think is this reasonable?

Make sure you include an identification of whether you think the jerk value is reasonable and safe for the butterfly.

Write a final statement that describes whether the initial equation for the movement of a butterfly is a realistic equation or not.