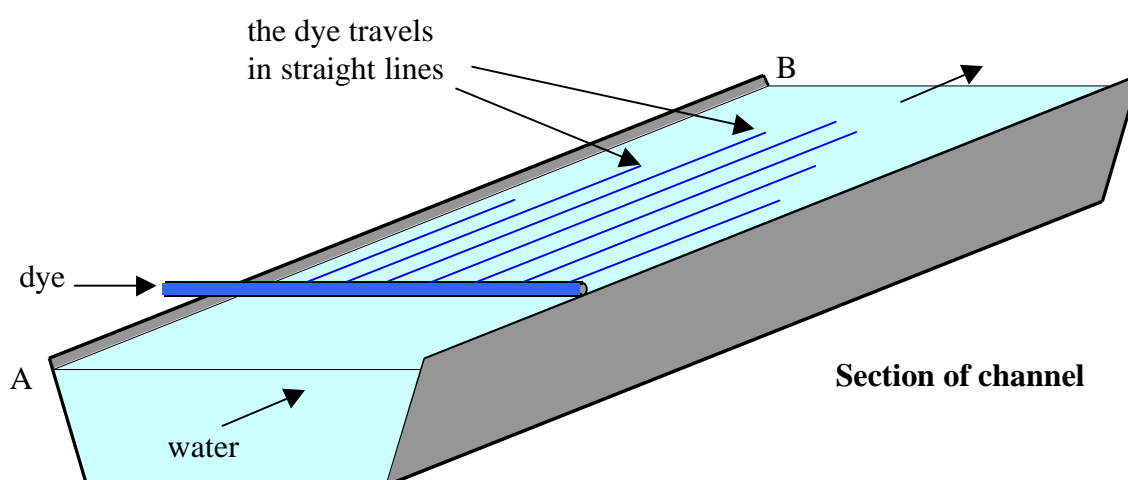


Water Flow – Data Sheet

In a laboratory experiment to study the flow of water along an open channel, dye is released into the stream at regular intervals across its width. When the water is pumped into the channel at a relatively low rate, the flow is steady and the dye travels along the channel in straight lines as shown in the diagram. If a photograph is taken a short time after the dye is released, the distance travelled, and hence the velocity of the stream, can be determined.



The results of two such experiments are given in the table below. Some of the values from the second experiment have been lost.

Perpendicular distance from edge of channel (AB) x metres	Velocity of water u metres per second	
	Experiment 1	Experiment 2
0	0	0
0.1	0.12	0.09
0.2	0.21	
0.3	0.26	
0.4	0.28	0.21
0.5	0.26	
0.6	0.21	
0.7	0.12	0.09
0.8	0	0

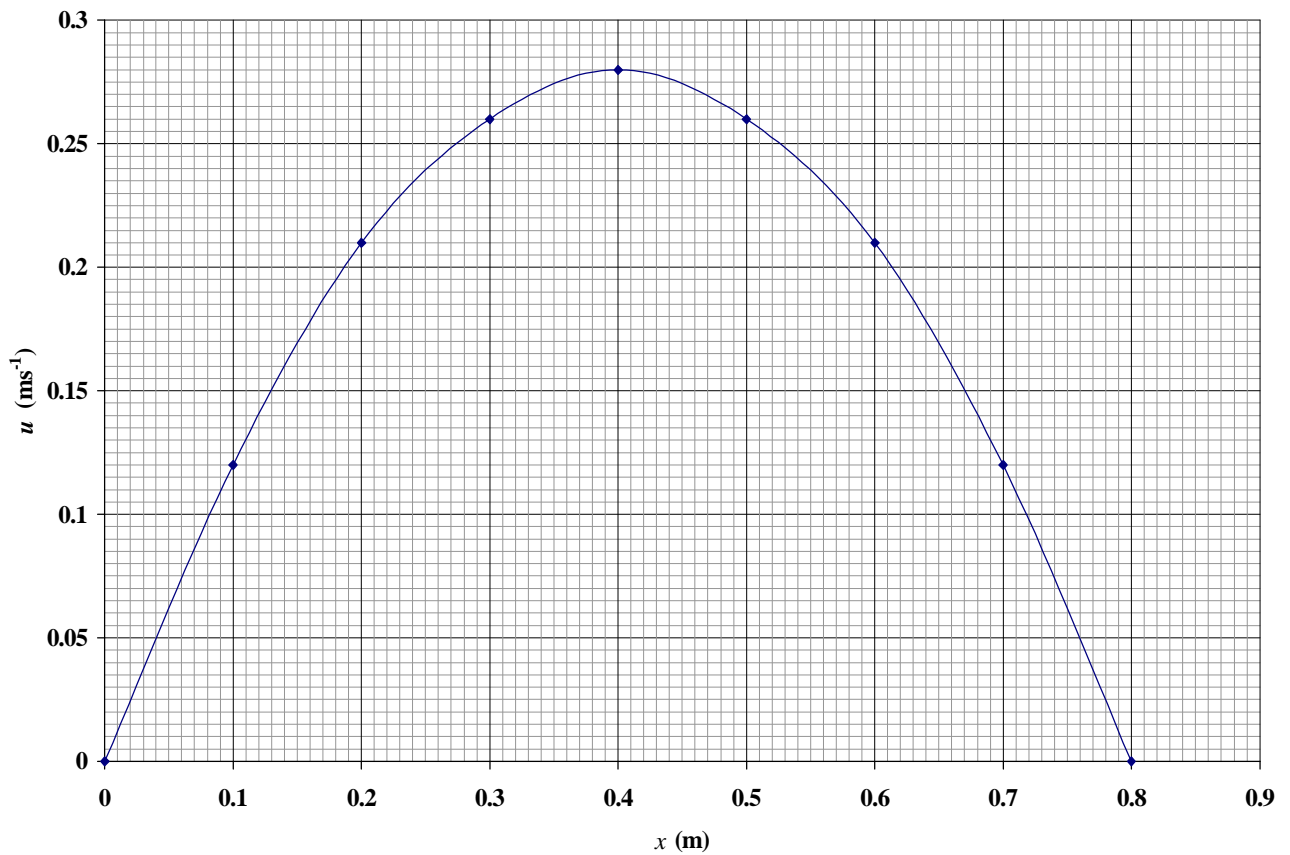


Water Flow**Sample Examination Question**

Throughout this question refer to the **Water Flow Data Sheet**.

The diagram below shows a graph of the velocity of the water, u metres per second, plotted against distance from the side of the channel, x metres, in the first experiment. The data points have been joined by a smooth curve.

Graph of water velocity against distance from side AB in Experiment 1



- a** Explain clearly how the values of u at the points where the curve meets the x axis and at the turning point relate to the real situation.



- b** The part of the curve for $0 \leq x \leq 0.2$ can be modelled by the linear function which passes through the points $(0, 0)$ and $(0.2, 0.21)$.
- (i)** Find the equation of this function giving your answer in the form $u = mx + c$.
 - (ii)** Calculate the error between the value of u predicted by this linear function when $x = 0.1$ and the actual velocity.
 - (iii)** Express this error as a percentage of the actual velocity.
- c** The complete curve can be modelled by a quadratic function of the form $u = ax(b - x)$ where a and b are constants.
- (i)** Find the values of a and b which will give a quadratic model with the same intercepts on the x axis and the same turning point as the curve which has been drawn using the original data.
 - (ii)** Calculate the error between the value of u predicted by the quadratic function when $x = 0.1$ and the actual velocity.
 - (iii)** Express this error as a percentage of the actual velocity.
- d** The rate at which the water is pumped along the channel was changed for the second experiment so that the maximum velocity was reduced from 0.28 metres per second to 0.21 metres per second.
- (i)** Find the percentage reduction in the maximum velocity.
 - (ii)** Assuming that the velocity of the water is reduced by the same proportion at all points across the channel, calculate the experimental values which were lost, giving your answers to two decimal places.
- e** In a third experiment the rate at which water is pumped along the channel is increased until the maximum velocity of the water is 0.32 metres per second. The velocity at the sides remains zero.
- (i)** Describe the geometrical transformation that could be applied to the graph shown to give a maximum velocity of 0.32 metres per second.
 - (ii)** Find the quadratic function that models the velocity for the new rate of flow.
 - (iii)** Use the function you found in part **e(ii)** to predict the velocity of the water at points in the channel where $x = 0.2$.

