

## WORKSHOP 2.9

Problems 1 & 2

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Let  $E$  denote the energy expenditure per metre of a fish swimming at a speed  $x$  against a current of speed  $u$ , where  $u$  is less than  $x$ . Predict the shape of the graph of the function  $E(x)$ , and draw your prediction on the board. Once you have settled on a prediction for the graph of  $E(x)$ , explain it to a TA.

According to the 1980 paper “Optimum Swimming Speeds in Fish: The Problem of Currents”, which was published in the *Canadian Journal of Fisheries and Aquatic Sciences*, the energy expenditure per metre can be modelled by the equation

$$E(x) = \frac{ae^{bx}}{x - u},$$

where  $a$  and  $b$  are positive constants depending on the species and size of the fish. Sketch the graph of the function  $E(x)$ , indicating where it is increasing and decreasing (you do not need to indicate where it is concave up or concave down). At what swimming speed does the fish travel most efficiently?