A Piper Cub is flying at a steady speed of $V_\infty = 30 \text{ m/s}$ (67 mph), at some low altitude where the air density is $\rho = 1.2 \text{ kg/m}^3$ and ambient pressure is $p_\infty = 100 000 \text{ Pa}$.

The figure below shows the velocity distribution $u(x)$ along a streamline just above the wing, as seen by the pilot. The flow direction is nearly along the $x$ axis, so we will consider only the accelerations and velocities in the $x$ direction, i.e. $v \approx 0$ and $w \approx 0$. To answer the questions below, and to give numerical results, use the local linear approximation to the velocity curve, shown as the heavy dashed line. Point A is at the midpoint of the 0.6 m interval shown.

1a) What is the local acceleration (or local derivative) of the fluid at point A? Explain.

1b) Estimate the convective acceleration (or convective derivative) of the fluid at point A.

1c) What is the true acceleration $a_x$ that the air feels at point A?

2) Using your result from 1) in the $x$-momentum equation, determine the streamwise pressure gradient $\partial p/\partial x$ at point A.

3a) Using the Bernoulli equation together with the known freestream conditions, determine the pressure distribution $p(x)$ near A corresponding to the approximate linear velocity.

3b) Determine $\partial p/\partial x$ at point A from the Bernoulli-derived $p(x)$ in 3a). Do the $x$-momentum equation and Bernoulli equation appear to be consistent in this case?