4.3

4.3 The velocity field of a flow is given by $\mathbf{V} = 2x^2t\,\mathbf{i} + [4y(t-1) + 2x^2t]\,\mathbf{j}$ m/s, where x and y are in meters and t is in seconds. For fluid particles on the x axis, determine the speed and direction of flow.

$u = 2x^2t$, $v = 4y(t-1) + 2x^2t$, $w = 0$

For particles on the x-axis $y = z = 0$ so that

$u = 2x^2t$ and $v = 2x^2t$

Thus, on the x-axis the velocity is in the x-y plane with

$$V = \sqrt{u^2 + v^2 + w^2} = \sqrt{(2x^2t)^2 + (2x^2t)^2}$$

or

$$V = \underline{\underline{2\sqrt{2}\,x^2t \ \frac{m}{s}}}$$

and

$$\tan\theta = \frac{v}{u} = \frac{2x^2t}{2x^2t} = 1 \quad \text{or} \quad \underline{\underline{\theta = 45^\circ}}$$