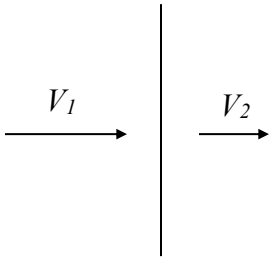
Determine the average deceleration of a gas (in *g*s) as it flows across the shock wave shown below. Assume: V_1=1800 ft/s, V_2=700 ft/s, and $l = 1*10^{-4}$ in.



shock wave of width *l*

SOLUTION:

The deceleration of a fluid particle is given by,

$$a = \frac{Du}{Dt} = \underbrace{\frac{\partial u}{\partial t}}_{=0 \text{ (steady)}} + u\frac{\partial u}{\partial x} \ , \qquad (1)$$

where,

$u = \frac{1}{2}(V_1 + V_2)$ (the average particle velocity)

$\frac{\partial u}{\partial x} = \frac{V_2 - V_1}{l}$ (the average velocity gradient)

Using the given data,

V_1 = 1800 ft/s

V_2 = 700 ft/s

l = $1*10^{-4}$ in = $8.3*10^{-6}$ ft

$\Rightarrow$ u = 1250 ft/s and $\partial u/\partial x$ = $-1.32*10^{8}$ s^{-1}

$\boxed{a = -1.65*10^{11} \text{ ft/s}^2 = -5.12*10^{9}\ g}$