Vorticity Homework
Interior Sverdrup Transport:

$$
\begin{aligned}
M_y &= -\frac{1}{\beta}\frac{\partial \tau_x}{\partial y} \\
M_y &= -\frac{\partial \tau_x}{\partial f}, \text{ where } \beta = \frac{\partial f}{\partial y} \\
M_y &= -\frac{(-0.05 - 0.05)}{2\Omega\big(sin(30°) - sin(20°)\big)} \\
M_y &= 4353.5 \text{ kg m}^{-1} \text{ s}^{-1}
\end{aligned}
$$

Distance, x, from the non-slip Western boundary to the axis of the Florida Straits Current:
Using dimensional analysis to get a mass transport balance,

$$
M_y \times \text{width of Atlantic at } 26° \text{ N} = \rho z \int_0^{x_{max}} v(x)dx
$$

Assume an approximate width of the North Atlantic, at 26° N, to be 6300 km, and substitute $v(x) = \frac{\partial v}{\partial x}\, x$, and $\frac{\partial \tau_x}{\partial y} = \rho k \frac{\partial v}{\partial x}$ to solve for x:

$$
\begin{aligned}
M_y \times 6300,000 &= \rho z \frac{\partial \tau_x}{\partial y}\frac{1}{\rho k}\frac{x^2}{2} \\
4353.5 \times 6300,000 &= z\left(\frac{0.1}{111,000 \times 10}\right)\frac{1}{k}\frac{x^2}{2}
\end{aligned}
$$

Assume that vorticity and transport balance is achieved within the upper 800 m (depth, z) of the Florida Straits, and $k = 2 \times 10^{-6}$.
Therefore, $\boxed{\text{x} = 39\ km\ (2\ s.f.)}$.

Maximum current, v, at the axis of the Florida Straits Current:

$$
\begin{aligned}
v &= \frac{\partial v}{\partial x}x \\
&= \frac{\partial \tau_x}{\partial y}\frac{1}{\rho k}x \\
&= \frac{0.1}{111,000 \times 10}\frac{1}{1025 \times 2 \times 10^{-6}} \times 39,000
\end{aligned}
$$

Therefore, $\boxed{\text{v} = 1.7 \text{ ms}^{-1} \quad (2 \text{ s.f.})}$