1) \( V_\theta = \frac{c}{r}, \ V_r = 0 \) is an irrotational, incompressible flow. From table: \( V_\theta = -\frac{c}{2\pi r} \). So for this case, \( C = -\frac{c}{2\pi} \). Also from table for this flow: \[ \psi = \frac{c}{2\pi} \ln r = -c \frac{\ln r}{2\pi} \] 

Alternatively, can obtain \( \psi(r, \theta) \) from \( \frac{\partial \psi}{\partial r} = -V_\theta = -\frac{c}{r} \Rightarrow 4\pi \psi = -c \ln r + f(\theta) \)

\[ \frac{\partial^2 \psi}{\partial \theta^2} = V_r = 0 \Rightarrow \psi \text{ is constant equal, set } f(\theta) \text{ arbitrarily} \]

b) \[ \nabla^2 \psi = \int_{R_2}^{R_1} V_\theta \, dr = \int_{R_2}^{R_1} \frac{c}{r} \, dr = C \ln \frac{R_2}{R_1} \]

Alternatively, use stream function: \[ \psi' = \psi - \psi_R = C \ln \frac{R_2}{R_1} \] same result.

c) This is an irrotational flow (it's on the table), so \[ i = 0 \]

Alternatively, can compute directly: \[ \nabla^2 \psi = \frac{1}{r} \frac{\partial}{\partial r} \left( r \frac{\partial \psi}{\partial r} \right) + \frac{1}{r^2} \frac{\partial^2 \psi}{\partial \theta^2} = \frac{1}{r^2} \left( r \cdot C \right) = 0 \]

d) Helmholtz Equation: \( \frac{D^2 \psi}{Dt^2} = 0 \), or \( \nabla \cdot \psi = 0 \) along streamlines.

So since \( \nabla \cdot \psi = 0 \) in bend, it will stay at \( \nabla \cdot \psi = 0 \) in straight section.

We have parallel flow in straight section, so \( V = 0 \), and \[ \frac{D^2 \psi}{Dy^2} = 0 \]

So \( \frac{D^2 \psi}{Dy^2} = 0 \), or \( U(y) = \text{const.} \). Correct answer is \( i \).
2). 

a) \[ V_r = \frac{\partial \phi}{\partial r} = V_\infty \cos \theta - \frac{K}{2\pi} \frac{1}{r^2} \cos \theta = \left( V_\infty - \frac{K}{2\pi} \frac{1}{r^2} \right) \cos \theta \]

On cylinder surface: \( V_r = 0 \) 

at \( r = R \): \[ V_\infty - \frac{K}{2\pi} \frac{1}{R^2} = 0 \Rightarrow K = 2\pi R^2 V_\infty \] \( \boxed{10} \)

b) \[ V_\theta = \frac{\partial \phi}{\partial \theta} = -V_\infty \sin \theta - \frac{K}{2\pi} \frac{\sin \theta}{r^2} - \frac{\Gamma}{2\pi r} = -V_\infty \left[ 1 + \frac{R^2}{r^2} \right] \sin \theta - \frac{\Gamma}{2\pi r} \]

On cylinder, \( r = R \), \( V_r = 0 \), so \( V = \sqrt{V_r^2 + V_\theta^2} = V_\theta = -2V_\infty \sin \theta - \frac{\Gamma}{2\pi R} \)

A: \( \sin \theta = 1 \), \( V = 2V_\infty + \frac{\Gamma}{2\pi R} \) \( \boxed{5} \)

B: \( \sin \theta = -1 \), \( V = 2V_\infty - \frac{\Gamma}{2\pi R} \) \( \boxed{5} \)

C: \( \sin \theta = 0 \), \( V = -\frac{\Gamma}{2\pi R} \) \( \boxed{5} \)

c) i) From a) \[ R^2 = \frac{K}{2\pi V_\infty} \], so to hold \( R \) constant if \( V_2 = 2V_1 \), \( K_2 = 2K \) \( \boxed{5} \)

ii) \( L' = \rho V_\infty R \), so to hold \( L' \) constant if \( V_2 = 2V_1 \), \( \Gamma_2 = \frac{1}{2} \Gamma \) \( \boxed{5} \)
3) a) Velocity components: $V_\infty$ 

At point A: 
\[ u = V_\infty - \frac{\lambda_1}{2} - \frac{\lambda_2}{2} = 0 \] (required) 
\[ 1 - \frac{\lambda_1}{2} - \frac{\lambda_2}{2} = 0 \] 
\[ \lambda_1 = 3 \] \[ \boxed{10} \]

b) At point B: 
\[ u = V_\infty + \frac{\lambda_1}{2} + \frac{\lambda_2}{2} \] 
\[ u = 1 + \frac{3}{2} - \frac{1}{2} = 2 \] \[ \boxed{5} \]

c) At large distances ($d \gg l$), the velocity field of a source panel becomes the same as that of a point source with the same total strength $\lambda = \lambda l$

So far away, the velocity of a source panel is $V_r = \frac{\lambda l}{2 \pi l}$

For this case, at point A:
\[ u = V_\infty - \frac{\lambda_1}{2} - \frac{\lambda_2 l}{2 \pi d} = 0 \] (required) 
\[ 1 - \frac{\lambda_1}{2} + \frac{l}{2 \pi d} = 0 \] 
\[ \lambda_1 = 2 + \frac{1}{10 \pi} \] \[ \boxed{10} \]