$$
\begin{aligned}
& \text { Volume of revolution }=\pi \int_{a}^{b} y^{2} d x \\
& \begin{array}{c}
\text { about } x \text {-axis } \\
\text { about } y \text {-axis }
\end{array}
\end{aligned}
$$

Exercise 4A
le) $y=\frac{\sqrt{\ln x}}{x}$ between $x=1$ and $x=2$

$$
\text { Vol }=\pi \int_{1}^{2} y^{2} d x=\pi \int_{1}^{2} \frac{\ln x}{x^{2}} d x
$$

Let $u=\ln x$

$$
\text { Let } \frac{d v}{d x}=x^{-2}
$$

$$
\begin{array}{ll}
\text { et } \quad v=\ln x & \text { Let } \frac{d v}{d x}=x^{-2} \\
\Rightarrow d v=\frac{1}{x} & \\
\Rightarrow \quad v=-x^{-}
\end{array}
$$

$$
\begin{aligned}
\Rightarrow \frac{d u}{d x} & =\frac{1}{x} \quad \Rightarrow v=-x^{-1}=-\frac{1}{x} \\
\pi \int_{1}^{2} \frac{\ln x}{x^{2}} d x & =v v-\int V \frac{d u}{d x} \\
& =\pi\left[\left[-\frac{\ln x}{x}\right]_{1}^{2}-\int_{1}^{2}-\frac{1}{x} \cdot \frac{1}{x} d x\right] \\
& =\pi\left[\left[-\frac{\ln x}{x}\right]_{1}^{2}+\int_{1}^{2} \frac{1}{x^{2}} d x\right] \\
& =\pi\left[-\frac{\ln 2}{2}--\frac{\ln 1}{1}+\left[-\frac{1}{x}\right]_{1}^{2}\right]
\end{aligned}
$$

$$
\begin{aligned}
& =\pi\left[-\frac{\ln 2}{2}-\frac{1}{2}--\frac{1}{1}\right] \\
& =\pi\left[\frac{1}{2}-\frac{\ln 2}{2}\right]=\frac{\pi}{2}(1-\ln 2)
\end{aligned}
$$

If) $y=\operatorname{cosec} x+\cot x$ from $x=\frac{\pi}{3}$ bo $x=\frac{\pi}{2}$

$$
\begin{aligned}
& \text { Vol }=\pi \int_{\frac{\pi}{3}}^{\frac{\pi}{2}} y^{2} d x=\pi \int_{\frac{\pi}{3}}^{\frac{\pi}{2}}\left(\operatorname{cosec}^{2} x+\cot ^{2} x+2 \operatorname{cosec} x \cot x\right) d x \\
& =\pi \int_{\frac{\pi}{3}}^{\frac{\pi}{2}}\left(2 \operatorname{cosec}^{2} x-1+2 \operatorname{cosec} x \cot x\right) d x \\
& =\pi[-2 \cot x-x]_{\frac{\pi}{3}}^{\frac{\pi}{2}}+\frac{\pi}{\frac{\pi}{3}} \int_{\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{2 \cos x}{\sin ^{2} x} d x
\end{aligned}
$$

$$
\begin{array}{rl|l}
\hline \text { Let } u=\sin x & x=\frac{\pi}{3} u=\frac{\sqrt{3}}{2} \\
\frac{d v}{d x}=\cos x & x=\frac{\pi}{2} u=1 \\
d u=\cos x d x & & \pi\left[\left(0-\frac{\pi}{2}\right)-\left(-\frac{2}{\sqrt{3}}-\frac{\pi}{3}\right)\right] \\
\int_{\frac{\sqrt{3}}{2}}^{1} \frac{2}{u^{2}} d u & & \left.\frac{2}{u}\right]_{\frac{\sqrt{3}}{2}}^{1} \\
& =\pi\left(-\frac{\pi}{6}+\frac{2}{\sqrt{3}}\right) \\
& +\pi\left(-2+\frac{4}{\sqrt{3}}\right) \\
& & \\
& & \pi\left(\frac{6}{\sqrt{3}}-2-\frac{\pi}{6}\right)
\end{array}
$$

