

$$1 \mid \int_1^2 \frac{e^{\frac{1}{x}}}{x^2} dx$$

$$\begin{aligned} \int -e^u du &= -e^u + C \\ &= -e^{\frac{1}{2}} + e^{\frac{1}{1}} \\ &= e - e^{\frac{1}{2}} \end{aligned}$$

$$2 \mid \int_0^1 r e^{\frac{r}{2}} dr$$

$$\begin{aligned} \int_0^1 r e^{\frac{r}{2}} dx &\Rightarrow r 2e^{\frac{r}{2}} - \int 2e^{\frac{r}{2}} dr \\ &= 2r e^{\frac{r}{2}} - \int 2e^{\frac{r}{2}} dr \\ &= 2r e^{\frac{r}{2}} - 4e^{\frac{r}{2}} \\ &= 2r e^{\frac{r}{2}} - 4e^{\frac{r}{2}} \\ &\Rightarrow 2e^{\frac{1}{2}} - 4e^{\frac{1}{2}} - (-4) \\ &= 4 - 2e^{\frac{1}{2}} \end{aligned}$$

$$3 \mid \textbf{TODO} \int_4^9 \frac{\ln y}{\sqrt{y}} dy$$

$$4 \mid \textbf{TODO} \int_0^{\sqrt{\pi}} \cos \sqrt{x} dx$$

$$\begin{aligned} \int_0^{\sqrt{\pi}} \cos \sqrt{x} dx &= x \cos \sqrt{x} + \int x \frac{1}{2\sqrt{x}} \sin \sqrt{x} dx \\ &= x \cos \sqrt{x} + \int \frac{\sqrt{x}}{2} \sin \sqrt{x} dx \\ &= x \cos \sqrt{x} + \frac{\sqrt{x}}{2} \int \sin \sqrt{x} dx \\ &= x \cos \sqrt{x} + \frac{\sqrt{x}}{2} \left( x \sin \sqrt{x} - \int \frac{\sqrt{x}}{2} \cos \sqrt{x} dx \right) \\ &= x \cos \sqrt{x} + \frac{\sqrt{x}}{2} \left( x \sin \sqrt{x} - \frac{\sqrt{x}}{2} \int \cos \sqrt{x} dx \right) \\ &= x \cos \sqrt{x} + \frac{\sqrt{x}}{2} x \sin \sqrt{x} - \frac{x}{4} \int \cos \sqrt{x} dx \\ \frac{x+4}{4} \int \cos \sqrt{x} dx &= x \cos \sqrt{x} + \frac{\sqrt{x}}{2} x \sin \sqrt{x} \\ \int \cos \sqrt{x} dx &= \frac{4x \cos \sqrt{x} + 2x\sqrt{x} \sin \sqrt{x}}{x+4} \end{aligned}$$

$$5 \mid \int_1^e \sin \ln x dx$$

$$\begin{aligned}\int_1^e \sin \ln x dx &= x \sin \ln x - \int x \frac{1}{x} \cos \ln x dx \\&= x \sin \ln x - \int \cos \ln x dx \\&= x \sin \ln x - \left( x \cos \ln x + \int x \cancel{\frac{1}{x}} \sin \ln x dx \right) \\&= x \sin \ln x - x \cos \ln x - \int \sin \ln x dx\end{aligned}$$

$$\begin{aligned}2 \int \sin \ln x dx &= x \sin \ln x - x \cos \ln x \\ \int \sin \ln x dx &= \frac{1}{2} x (\sin \ln x - \cos \ln x) \\ \implies \frac{1}{2} e (\sin 1 - \cos 1) - \frac{1}{2} (\sin 0 - \cos 0) \\ &= \frac{e}{2} (\sin 1 - \cos 1) + \frac{1}{2}\end{aligned}$$