1. Compute $\int \frac{\sec^2(x)}{\tan(x)}\, dx$ $= \int \frac{\boxed{\sec^2 x\, dx}}{\boxed{\tan x}} = \int \frac{du}{u} = \ln|u| + C$

$= \ln|\tan x| + C$

let $u = \boxed{\tan x}$

$du = \boxed{\sec^2 x\, dx}$

2. Compute $\int \sec^2(x)\tan(x)\, dx$ $= \int (\underline{\tan x})(\underline{\sec^2 x\, dx}) = \int u\, du$

$= \frac{1}{2}u^2 + C$

$= \frac{1}{2}(\tan x)^2 + C$

let $u = \boxed{\tan x}$

$du = \boxed{\sec^2 x\, dx}$

3. Compute $\int \frac{\sin(\theta)}{1+\cos(\theta)} d\theta$ $= \int \frac{\boxed{\sin\theta\, d\theta}}{\boxed{1+\cos\theta}} = \int \frac{-du}{u} = -\int \frac{du}{u}$

$= -\ln|1+\cos\theta| + C$

let $u = \boxed{1+\cos\theta}$

$du = -\sin\theta\, d\theta$

$-du = \boxed{\sin\theta\, d\theta}$

4. Compute $\int \frac{1}{x\ln(x)}\,dx$ $= \int \left(\frac{1}{\boxed{\ln x}}\right)\cdot\boxed{\left(\frac{dx}{x}\right)} = \int \frac{1}{u}\,du = \ln|u| + C$

$= \ln|\ln x| + C$

let $u = \boxed{\ln x}$

$du = \boxed{\frac{1}{x}dx}$

5. Compute $\int \frac{\sin(4/x)}{x^2}\,dx$ $= \int \sin(4x^{-1})\boxed{\left(\frac{dx}{x^2}\right)} = \int (\sin u)\left(\frac{-1}{4}du\right)$

let $u = \boxed{4x^{-1}}$

$du = -4x^{-2}\,dx$

$-\frac{1}{4}du = \boxed{\frac{dx}{x^2}}$

$= -\frac{1}{4}\int \sin u\,du$

$= \frac{1}{4}\cos u + C$

$= \frac{1}{4}\cos(4x^{-1}) + C$

6. Compute $\int \frac{e^x}{e^x-3}\,dx$ $= \int \left(\frac{1}{\boxed{e^x-3}}\right)(e^x dx) = \int \frac{1}{u}\,du$

let $u = \boxed{e^x-3}$

$du = e^x\,dx$

$= \ln|u| + C$

$= \ln|e^x-3| + C$

7. Compute $\int \frac{1}{9+x^2}\,dx$ $= \frac{1}{9}\int \frac{1}{1+\left(\boxed{\frac{x}{3}}\right)^2}\,\boxed{dx} = \frac{1}{9}\int \frac{1}{1+u^2}(3\,du)$

let $u = \boxed{x/3}$

$du = \frac{1}{3}dx$

$3\,du = \boxed{dx}$

$= \frac{1}{3}\int \frac{du}{1+u^2} = \frac{1}{3}\arctan u + C$

$= \frac{1}{3}\arctan\left(\frac{x}{3}\right) + C$

8. Compute $\int \sqrt{x}(x^4+x)\,dx$ $= \int \left(x^{9/2} + x^{3/2}\right)dx = \frac{2}{11}x^{\frac{11}{2}} + \frac{2}{5}x^{\frac{5}{2}} + C$

9. Compute $\int \cos(x)\sin(\sin(x))\,dx$ $= \int \left(\sin\left(\boxed{\sin x}\right)\right)\left(\boxed{\cos x\,dx}\right)$

Let $u = \boxed{\sin x}$

$du = \boxed{\cos x\,dx}$

$= \int \sin(u)\,du$

$= -\cos u + C$

$= -\cos(\sin x) + C$

10. Compute $\frac{d}{dx}[x\ln(x)-x]$. Then compute $\int s^2\ln(s^3)\,ds$ $= \int (\ln(\boxed{s^3}))(s^2 ds) =$

$$\boxed{\frac{d}{dx}[x\ln x - x] = 1\cdot \ln x + x\cdot\frac{1}{x} - 1 = \ln x + 1 - 1 = \ln x.}$$

Let $u = \boxed{s^3}$

$du = 3s^2 ds$

$\frac{1}{3}du = s^2 ds$

$= \frac{1}{3}\int \ln u\, du = \frac{1}{3}(u\ln u - u) + C$

$= \frac{1}{3}(s^3\ln(s^3) - s^3) + C$

11. Compute $\int x\sqrt{x-1}\,dx$ $= \int (u+1)u^{\frac{1}{2}}du = \int (u^{3/2} + u^{\frac{1}{2}})du$

let $u = \boxed{x-1}$

$u+1 = \boxed{x}$

$du = \boxed{dx}$

$= \frac{2}{5}u^{5/2} + \frac{2}{3}u^{3/2} + C$

$= \frac{2}{5}(x-1)^{5/2} + \frac{2}{3}(x-1)^{3/2} + C$

12. Compute $\int_1^3 \frac{(\ln(x))^3}{x}\,dx$ $= \int_0^{\ln 3} u^3 du = \frac{1}{4}u^4\Big]_0^{\ln 3}$

let $u = \ln x$

$du = \frac{1}{x}dx$

$x=1,\ u=0$

$x=3,\ u=\ln 3$

$= \frac{1}{4}((\ln 3)^4 - 0)$

$= \frac{(\ln 3)^4}{4}$