CHM 3400 – Fundamentals of Physical Chemistry
Math Review

1. Logarithms and exponentials

$\ln(a) + \ln(b) = \ln(a \cdot b)$ $\qquad$ $\exp(a) \cdot \exp(b) = \exp(a+b)$

$\ln(a) - \ln(b) = \ln(a/b)$ $\qquad$ $\exp(-a) = \dfrac{1}{\exp(a)}$

$\ln(a^b) = b \ln(a)$ $\qquad$ $[\exp(a)]^b = \exp(ab)$

Note that in the above $\exp(a) = e^a$. Also note that logarithm and exponential are inverse operations, and so

$\ln[\exp(a)] = \exp(\ln(a)) = a$

2. Derivatives

$\dfrac{d}{dx} = x^n = n x^{n-1}$ $\qquad$ $\dfrac{d}{dx}(a \cdot b) = a \cdot \dfrac{db}{dx} + b \cdot \dfrac{da}{dx}$

$\dfrac{d}{dx} \sin(ax) = a \cos(ax)$ $\qquad$ $\dfrac{d}{dx} \cos(ax) = - a \sin(ax)$

$\dfrac{d}{dx} \exp(ax) = a \exp(ax)$

$\dfrac{d}{dx} \ln(x) = \dfrac{1}{x}$ $\qquad$ $\dfrac{d}{dx} \ln(ax) = \dfrac{d}{dx} \{ \ln(a) + \ln(x) \} = \dfrac{1}{x}$

3. Integrals

$\int x^n \, dx = \dfrac{x^{n+1}}{(n+1)}$ except for $n = -1$ $\qquad$ $\int x^{-1} \, dx = \int (1/x) \, dx = \ln(x)$

$\int \exp(ax) \, dx = \dfrac{\exp(ax)}{a}$ $\qquad$ $\int \ln(x) \, dx = x \ln(x) - x$

$\int \sin(ax) \, dx = - \dfrac{\cos(ax)}{a}$ $\qquad$ $\int \cos(ax) \, dx = \dfrac{\sin(ax)}{a}$

4. Taylor and other series expansions

General form (Taylor expansion of f(x) about the point a)

$$f(x) = f(a) + (x - a)(df/dx)_a + \frac{(x-a)^2}{2!}(d^2f/dx^2)_a + \frac{(x-a)^3}{3!}(d^3f/dx^3)_a + \ldots \frac{(x-a)^n}{n!}(d^nf/dx^n)_a + \ldots$$

$$\exp(x) = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots$$

$$\sin(x) = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \ldots \qquad \cos(x) = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \ldots$$