

**CHM 3400 – Fundamentals of Physical Chemistry
Math Review**

1. Logarithms and exponentials

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

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

$$\ln(a) - \ln(b) = \ln(a/b)$$

$$\exp(-a) = \frac{1}{\exp(a)}$$

$$\ln(a^b) = b \ln(a)$$

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

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

$$\frac{d}{dx} x^n = n x^{n-1}$$

$$\frac{d}{dx} (a \cdot b) = a \cdot \frac{db}{dx} + b \cdot \frac{da}{dx}$$

$$\frac{d}{dx} \sin(ax) = a \cos(ax)$$

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

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

$$\frac{d}{dx} \ln(x) = \frac{1}{x}$$

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

3. Integrals

$$\int x^n dx = \frac{x^{n+1}}{(n+1)} \quad \text{except for } n = -1$$

$$\int x^{-1} dx = \int (1/x) dx = \ln(x)$$

$$\int \exp(ax) dx = \frac{\exp(ax)}{a}$$

$$\int \ln(x) dx = x \ln(x) - x$$

$$\int \sin(ax) dx = -\frac{\cos(ax)}{a}$$

$$\int \cos(ax) dx = \frac{\sin(ax)}{a}$$

4. Taylor and other series expansions

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

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

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

$$\sin(x) = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \dots$$

$$\cos(x) = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \dots$$