Physics 213 **Problem 4** **Week 1**

Logarithms and exponentials (required background)

Here we use "log" for log base 10, "ln" for log base e ("natural" logarithm).

Definitions:
$x = e^{\ln(x)}$
$x = 10^{\log(x)}$

The main math facts used in this review problem are:

I. $\ln(AB) = \ln(A) + \ln(B)$ II. $\ln(A^B) = B \ln(A)$

III. $\frac{d}{dx}e^u = e^u \frac{du}{dx}$ IV. $\frac{d}{dx}\ln(u) = \frac{1}{u}\frac{du}{dx}$

V. III and IV are based on the chain rule: $\frac{d}{dx} f(u) = \frac{df}{du}\frac{du}{dx}$ w

a) What is log(0.01) ?

b) Let ln(x) = 3.2, and ln(y)= -7.2. What is ln(xy) ?

c) Let $y = e^{306554}$. What is ln(y) ?

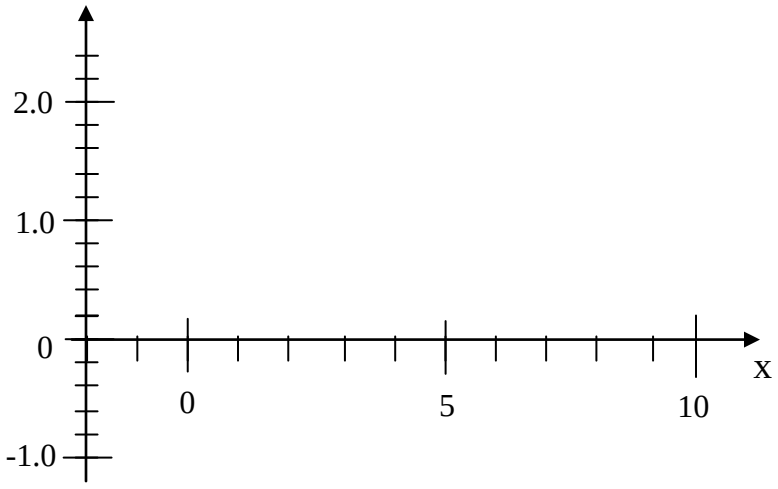
d) Give an expression for $\frac{d}{dx}e^{35x}$.

e) Give an expression for $\frac{d}{dx}e^{-10x^2}$:

f) Give an expression for $\frac{d}{dx}\left(5\ln(3x)\right)$:

g) Give an expression for $\frac{d}{dx}\left(5\ln\left(x^3\right)\right)$:

h) Plot a few points for log(x) and ln(x):
(x = 0.5, 1, 2, 5, 10)
What about x = 0?



Note $x = 10^{\log(x)}$ and $10 = e^{\ln(10)}$
so $x = e^{\ln(x)} = e^{\ln(10)\log(x)}$ and
ln(x) = ln(10) log(x) = **2.303 log(x)**
They are proportional**.**

i) Stirling's approximation says that ln N! is approximately N ln N – N.

Fill out the table below to see how accurate this approximation is.

N	ln N!	N ln N – N
10		
20		
50		
100		
1000		

j) Later in the course we will also need to know how to calculate:
d (ln N!)/dN

Use Stirling's approximation to rewrite this in a simpler form.