Homework A

PHY3513 **Due: Wednesday, Jan 22**

1. (a) $2+\frac{1}{2}+\frac{1}{3!}+\frac{1}{4!}+\frac{1}{5!}+...=??$

   (b) $1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+\frac{1}{5}-\frac{1}{6}...=??$

2. Expand $(1-2tz+t^2)^{-1/2}$ in powers of t assuming that t is small. Collect the coefficients of t^0, t^1. and t^2.

3. The displacement z of a particle of rest mass m_0, resulting from a constant force $m_0 g$ along the z-axis is

$$z=\frac{c^2}{g}\left\{\left[1+\left(g\frac{t}{c}\right)^2\right]^{1/2}-1\right\}$$

including relativistic effect. Find the displacement z as a power series in time t. Compare with the classical result,

$$z=\frac{1}{2}gt^2 .$$

4. A magnetic system has specific heat which is a function of applied magnetic field, H and temperature, T. It can be represented theoretically by

$$C(T,H)=C(H/T)=N\frac{(H/T)^2}{\cosh^2(H/T)}$$

where N is constant.

(a) Expand $C(T,H)$ in power of (H/T) up to $(H/T)^4$ assuming $H << T$.
(b) Sketch (freehand) the behavior of your answer as a function of $x = H/T$.

5. (1.4) For parts (a) and (b) express answers as whole numbers to a precision of ±1, for (c) use Stirling's formula and express answer as 10 raised to some power.

6. The probability $P(n)$ that an event characterized by a probability p occurs n times in N trials is given by the binomial distribution

$$P(n)=\frac{N!}{n!(N-n)!}p^n(1-p)^{N-n} .$$

Consider a case where $p << 1$ and $N >> 1$.

(a) Show that $(1 - p)^{N-n} \approx e^{-Np}$ using $\ln(1-p) \approx -p$.
(b) Show that $N!/(N-n)! \approx N^n$.

(c) Therefore, you can show that $P(n) = \frac{\lambda^n}{n!} e^{-\lambda}$ where $\lambda = Np$.You have just demonstrated that the binomial distribution for small p and large N turns into the Poisson distribution!

7. (2.5)

8. (3.3)

9. (3.4)

10. (3.5) Do (a) through (g), skip (h) and (i), and do (j).