Physics 663 Problem Set 2 **Due 15 October 2008**

Read Peskin and Schroeder (PS) Chapters 7, 9, 10, 11 (and Ryder 6).

Do Problems:

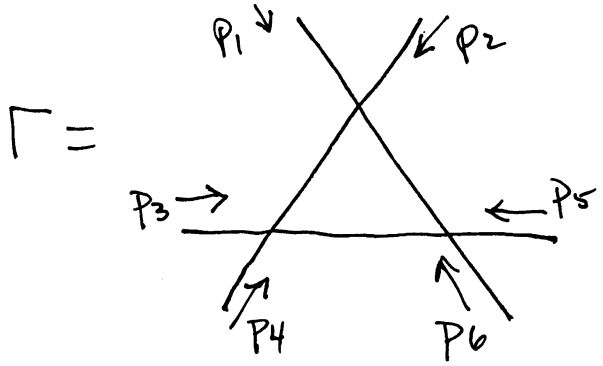
1.) Consider a self interacting scalar field theory with mass m. The Lagrangian is given by

$$\mathcal{L} = \frac{1}{2}\partial_\mu\phi\partial^\mu\phi - \frac{1}{2}m^2\phi^2 - \frac{\lambda}{4!}\phi^4. \tag{1}$$

Calculate the contribution to

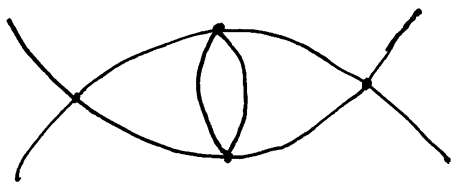
$$G^{(6)} = \frac{< 0 \text{ out}|\mathrm{T}\phi(x_1)\cdots\phi(x_6)|0 \text{ in} >}{< 0 \text{ out}|0 \text{ in} >} \tag{2}$$

from the diagram Γ. Evaluate this at all $p_i^\mu = 0$, $i = 1, 2, \ldots, 6$.

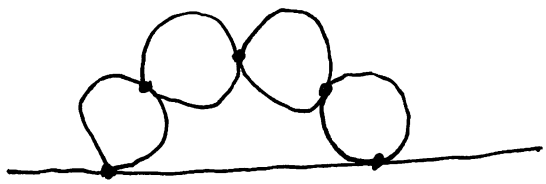


2.) What are the symmetry numbers for the following diagrams?

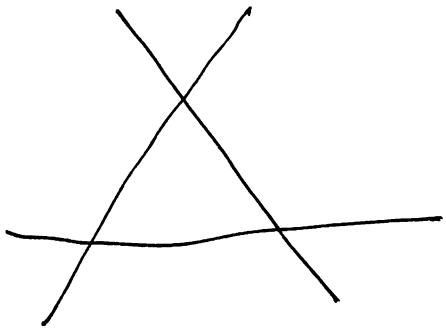
a)



2.b.)



c.)



3.) Consider the field theory of a self-interacting complex scalar field

$$\begin{aligned} \phi &\equiv \frac{1}{\sqrt{2}}(\sigma + i\pi) \\ \phi^\dagger &= \frac{1}{\sqrt{2}}(\sigma - i\pi), \end{aligned} \tag{3}$$

with $\sigma^\dagger = \sigma$ and $\pi^\dagger = \pi$, described by the Lagrangian

$$\mathcal{L} = \partial_\mu \phi^\dagger \partial^\mu \phi - m^2 \phi^\dagger \phi - \frac{\lambda}{2}(\phi^\dagger \phi)^2. \tag{4}$$

What are the Feynman rules? Write the expressions for the low order contributions to

$$G^{(2,2)} = \frac{< 0 \text{ out}|\mathrm{T}\phi(x_1)\phi(x_2)\phi^\dagger(x_3)\phi^\dagger(x_4)|0 \text{ in} >}{< 0 \text{ out}|0 \text{ in} >} \tag{5}$$

(do not do the loop integrals).

What is

$$\frac{< 0 \text{ out}|\mathrm{T}J^\mu(x)\phi(x_1)\phi^\dagger(x_2)|0 \text{ in} >}{< 0 \text{ out}|0 \text{ in} >} \tag{6}$$

in lowest order where $J^\mu(x) = -\phi^\dagger(x) \overleftrightarrow{\partial^\mu} \phi(x)$.