

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS  
Particle Physics (Phys. 441)

**Assignment # 5**  
**Due to Saturday December 25, 2004**

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1. Problem 3.13 in Griffiths (page 101). (15 pts)
2. Problem 3.14 in Griffiths (page 101). (15 pts)
3. Problem 3.16 in Griffiths (page 101). (20 pts)
4. Problem 3.22 in Griffiths (page 102). (35 pts)
5. Problem 3.23 in Griffiths (page 102). (15 pts)
6. Problem 6.7 in Griffiths (page 211). (15 pts)
7. Consider a toy model in which there are only four particles  $A$ ,  $B$ ,  $C$  and  $D$  with masses  $m_A = m_B = m_C = 0$ , and  $m_D = m$ . The particles interact according to the fundamental vertices shown in the figure below. The scattering process  $A + \bar{A} \rightarrow B + \bar{B}$  has two main contributions; the first is due to the exchange of particle  $C$  and the second is due to the exchange of particle  $D$

Figure 1: The fundamental vertices for the toy model.

- (a) Find the cross section for the above process due to the exchange of particle  $C$ . Express your answer in terms of the invariant Mandelstam variable  $s$ . (5 pts)

- (b) Plot the cross section that you obtained in the previous part as a function of  $s$ . (5 pts)
- (c) Find the cross section for the above process due to the exchange of particle  $D$ . (10 pts)
- (d) Plot the cross section that you obtained in the previous part as a function of  $s$ . (5 pts)
- (e) Find the total cross section for the above process and plot it as a function of  $s$ . (10 pts)
- (f) If one make the following rough particle assignments;  
 $A \equiv e^-$ ,  $B \equiv \mu^-$ ,  $C \equiv \gamma$ , and  $D \equiv Z^0$ . What can you tell about the total cross section? (10 pts)