

## Physics 556/714 Problem Set #2

due *beginning of class* Thursday 25 Sept

1. For the two body decay  $A \rightarrow B + C$ , the energy of particle B in the rest frame of particle A can be written as:

$$E_B = \frac{m_A^2 - m_C^2 + m_B^2}{2m_A}$$

- a) Derive this formula.
  - b) What do you expect the energy of each outgoing particle to be if  $m_A = m_B + m_C$ ? Does the above formula reproduce your expectation?
2. Suppose a positively charged particle of small mass  $m$  and momentum  $p$ , collides head on with a positively charged particle at rest of large mass  $M$ .
    - a) Assuming that the scattering takes place in one dimension (as it would for a head on collision) what is the final momentum of the mass  $m$  in the limit of large  $M$ ?
    - b) If we were to assume that this scattering event were described by the exchange of a single virtual photon, what would be the mass-squared of the virtual photon?
  3. Griffiths problem 2.2: "Sketch the lowest-order Feynman diagram representing Delbruck scattering". Strictly speaking, you might say there are many lowest order diagrams, though they all look the same in the drawing. Can you comment on this?
  4. Griffiths problem 2.5: "Which decay do you think would be more likely,..."
  5. Griffiths problem 2.7 "Examine the following processes,..."
  6. What is the minimum photon energy needed to create an  $e^+e^-$  pair when the photon collides
    - a) with a free electron at rest, and
    - b) with a free proton at rest?

### 714 students please also do the following:

7. In problem 2 above, how do we interpret a negative mass-squared? To explain this, draw a traditional space-time diagram for the reaction in problem 2 that shows an imaginary mass virtual photon. Explain your reasoning.