Physics 3710 – Problem Set #13

## Some weak interaction stuff

Questions 1-4 refer to the diagram at the right. In it, a particle  $p_1$  absorbs a particle X and transforms into a particle  $p_2$ . Time increases vertically.

1. Suppose  $p_1$  is a *charged lept*on and  $p_2$  is a *neutrino* in the same lepton family. What must *X* be?

2. Suppose  $p_1$  is a *charged anti-lepton* and  $p_2$  is an *anti-neutrino* in the same lepton family. What must *X* be?

3. Suppose  $p_1 = p_2$  is the same *neutrino*. What must *X* be?

4. Suppose  $p_1 = p_2$  is the same *charged lepton*. What *might* X be? (Careful.)

Questions 5-8 refer to the diagram at the right, which shows the decay of a lepton  $l^-$ . Refer to the masses in the tables in notes SM1. Remember, a virtual particle does not have to have the same mass as the corresponding real particle.

5. Suppose  $l^-$  is an electron. What must  $p_1$  and  $p_2$  be? (Careful.)

6. Suppose  $l^{-}$  is an muon. What must  $p_1$  and  $p_2$  be?

7. Suppose  $l^{-}$  is an tau lepton. What *leptons* might  $p_1$  and  $p_2$  be?

8. The tau lepton can sometimes decay into *quarks*, the most likely ones being the lightest. What would  $p_1$  and  $p_2$  be in that case? (Note that the two quarks so produced are not free; they immediately exchange gluons forming a pion, which is much heavier than the two quarks. The muon doesn't decay into quarks because it isn't sufficiently heavy.)

