6380 homework 2 is due on Friday September 30 at 1 pm noon Dallas time.

1. Which of the following reactions are forbidden by the conservation laws? Explain why. For allowed processes describe the type of interactions responsible. You can use textbooks and slides of past lectures. Particle properties listing, including mass, spin and other quantum numbers of each can be found in Particle Data Tables on the web at http://pdg.lbl.gov/

e – electron, μ - muon, γ– photon, ν – neutrino, p – proton, τ – tau lepton, Λ– lambda (strange) baryon, π - pion (pi meson). If no additional condition is provided assume high energy process.

a) $e^+ + e^- \rightarrow \mu^+ + \mu^-$ **Allowed**

b) $p \rightarrow e^+ + \gamma + \pi^0$ **Forbidden by baryon number conservation**

c) $p + \bar{p} \rightarrow n + K^+ + K^+ + \pi^- + \pi^+ + \pi^0$ **Forbidden by baryon number and by strangeness conservation**

d) $\mu^- \rightarrow e^- + \bar{\nu}_e$ **Forbidden by muon number conservation**

e) $\tau^+ \rightarrow e^+ + e^+ + e^-$ **Forbidden by tau number conservation**

f) $\Lambda^0 \rightarrow p + \pi^0$ **Forbidden by charge conservation**

g) $\pi^- + p \rightarrow n + K^+ + K^- + \pi^+ + \pi^+ + \pi^- + \pi^-$ **Allowed**

h) $\tau^+ \rightarrow \pi^+ + \pi^+ + \pi^- + \pi^0 + \pi^0$ **Forbidden by tau number conservation**

i) $\Xi^- \rightarrow \Lambda + \pi^-$ **Allowed**

2. In what circumstances the decay $p \rightarrow n + e^+ + \nu_e$ could be allowed?

When both initial proton and final state neutron are bound in the atomic nucleus, i.e., have virtual masses. The process is occurring by electron capture from the lowest atomic orbit. eg $O_8^{14} \rightarrow N_7^{14} + e^+ + \nu_e$

3. Explain why no antiparticle plays a role in chemical processes.

There are no antiparticles in nature. An antiparticle would have first to be produced in a strong interaction process i.e., at very short distances that are not accessible to the long-range electromagnetic interactions regulating chemistry. It would then annihilate before chemical reaction takes place.