Phys 174 Homework Chapter 31

No need to submit this problem set.

Constants: $e = 1.6 \times 10^{-19}C$, $h = 6.63 \times 10^{-34}Js$, $\epsilon_0 = 8.85 \times 10^{-12}C^2N^{-1}m^{-2}$, $\mu_0 = 4\pi \times 10^{-7}Tm/A$, Avogadro number $N_A = 6 \times 10^{23}$, $1u = 1.6605 \times 10^{-27}kg = 931.494MeV/c^2$.

1. Write down the four fundamental forces of nature in decreasing order of strength. What are their force carrier?

   Strong (gluon), electromagnetic (photon), weak (W, Z boson), gravitational (graviton)

2. Which of the four fundamental forces of nature are short range?

   Strong and weak

3. What is the difference between an electron and its anti-particle the positron?

   Opposite charge

4. How much energy (in $10^{14}J$) is released if $1g$ of matter is combined with $1g$ of anti-matter?

   $1.8 \times 10^{14}J$

5. What are hadrons and leptons?

   Hadrons = particles that interact primarily through strong interactions = particles that contains constituents (quarks) that carry color charge
   Leptons = particles that interact through weak interactions = particles that carries weak charge.

6. What are the two subclasses of hadrons and what are their spins?

   Mesons (spin 0, 1) Baryons (spin 1/2, 3/2)

7. What is the spin of leptons? Write down the six leptons.

   1/2
   $e^-, \nu_e, \mu^-, \nu_\mu, \tau^-, \nu_\tau$

8. What are bosons, what are fermions?

   Bosons: particles with integer spins
   Fermions: particles with half-integer spins

9. Write down all six quarks and their charges (in units of e). Are they bosons or fermions?

   $\begin{pmatrix} u : +2/3 \\ d : -1/3 \end{pmatrix} \begin{pmatrix} c : +2/3 \\ s : -1/3 \end{pmatrix} \begin{pmatrix} t : +2/3 \\ b : -1/3 \end{pmatrix}$

   All fermions.

10. Write down the quark composition of the proton and the neutron.

    p: uud, n:ddu