Phy107 Chapter 18 Review Questions

1. When we say 'the vacuum is not empty', we mean that

It is filled by atoms

It is full of curled-up extra dimensions

Particle-antiparticle pairs are being spontaneously created and destroyed.

It is full of photons from the big bang.

2. A top quark (charge +2/3e) will decay into a bottom quark (charge -1/3e). What particle will be emitted during this decay.

W⁺

Z⁰

W⁻

Photon
3. A neutron is a composite particle consisting of up quarks (charge +2/3) and down quarks (charge -1/3). What is a possible internal configuration?

   uuu

   uud

   udd

   ddd

4. The strong force between nucleons (protons or neutrons) in a nucleus arises from

   The electromagnetic force

   The weak force

   The color force

   The gravitational force
5. Neutrinos interact via

The electromagnetic force

The weak force

The color force

All of the above.

6. The difference between the generations of matter particles is

Their charge.

Their interactions.

Their speeds.

Their mass.
7. If the Higgs field were not present, particles would

all have the same charge

have zero mass

not interact with each other

not have antiparticles

8. In string theory, fundamental particles are associated with

Excited states of the string.

The speed of the string.

Interactions between strings.

The spin of a string.
9. As a result of some interaction, a neutrino changes into an electron. What particle could be responsible for the interaction?

   Z

   Gluon

   Photon

   W

10. A meson is a bound state of two quarks. Which of the following could be a neutral (electrical charge zero) meson?

   up - anti-down

   up - down

   up - anti-up

   up-up
11. String theory is only consistent in ten dimensions. In order to make predictions for our four-dimensional world, the 'extra' dimensions are ignored are made very small are annihilated are trapped inside black holes
Solutions:

1. C

Due to the energy uncertainty principle, particle-anti-particle pairs are continually fluctuating into existence and then disappearing.

2. A

The charge changes by -1, so that whatever particle is emitted must carry away a charge of +1. The only positively charged particle in this list is the W+.

3. C

The neutron has zero electrical charge. The only combination here that has zero charge is udd = 2/3 + (-1/3) + (-1/3).

4. C

The strong force between nucleons is an effect of the interaction between quarks in side the nucleons, which interact via the color force.

5. B

Neutrinos are fundamental particles, and are leptons. They also have zero electrical charge (neutral), so they don't interact via the EM force. Since they are not quarks, and are not made from quarks, they do not interact via the color force (do not have color charge). They interact mainly through the weak force.

6. D

The generations are copies of each other, except that the particles in higher generally are more massive than their counterparts.
7. B

*Particles acquire mass by interacting with the Higgs field. If the Higgs field were not present, all particle masses would be zero.*

8. A

*A string is a collection of points in space. The classical analogy is a guitar string, which can have several vibrational modes. Each vibrational mode can be shown to behave as a different particle.*

9. D

*The neutrino has zero electrical charge ("little neutral one"), and changes into something with negative electrical charge. Whatever particle was emitted must have carried away positive charge. The only charged particle in this list is the W. In particular the W⁺ would be the appropriate particle.*

10. C

*The up has charge 2/3, and the anti-up has charg -2/3. This gives total charge zero. None of the other combinations give a net charge of zero.*

11. B

*The extra dimensions are compactified in a topological way so that become so tightly curved (small) that we are not aware of them. The way in which this is done determines the spectrum of particles.*