Concept Items

23.1 The Four Fundamental Forces 1.

What forces does the inverse square law describe?

a. the electromagnetic and weak nuclear force
b. the electromagnetic force and strong nuclear force
c. the electromagnetic force and gravity
d. the strong nuclear force and gravity

2.

Do the carrier particles explain the loss of mass in nuclear decay?

a. no
b. yes

3.

What happens to the rate of voltage oscillation within a synchrotron each time the particle completes a loop?

a. The rate of voltage oscillation increases as the particle travels faster and faster on each loop.
b. The rate of voltage oscillation decreases as the particle travels faster and faster on each loop.
c. The rate of voltage oscillation remains the same each time the particle completes a loop.
d. The rate of voltage oscillation first increases and then remains constant each time the particle completes a loop.

4.

Which of the four forces is responsible for ionic bonding?

a. electromagnetic force
b. gravity
c. strong force
d. weak nuclear force

5.

What type of particle accelerator uses oscillating electric fields to accelerate particles around a fixed radius track?

a. LINAC
b. synchrotron
c. SLAC
d. Van de Graaff accelerator

23.2 Quarks 6.

How does the charge of an individual quark determine hadron structure?

a. Since the hadron must have an integral value, the individual quarks must be combined such that the average of their charges results in the value of a quark.
b. Since the hadron must have an integral value, the individual atoms must be combined such that the sum of their charges is less than zero.
c. The individual quarks must be combined such that the product of their charges is equal to the total charge of the hadron structure.
d. Since the hadron must have an integral value of charge, the individual quarks must be combined such that the sum of their charges results in an integral value.

7.

Why do leptons not feel the strong nuclear force?

a. Gluons are the carriers of the strong nuclear force that interacts between quarks through color interactions, but leptons are constructed of quarks that do not have gluons.
b. Gluons are the carriers of the strong nuclear force that interacts between quarks through mass interactions, but leptons are not constructed of quarks and are not massive.
c. Gluons are the carriers of the strong nuclear force that interacts between quarks through mass interactions, but leptons are constructed of the quarks that are not massive.
d. Gluons are the carriers of the strong nuclear force that interacts between quarks through color interactions, but leptons are not constructed of quarks, nor do they have color constituents.

8.

What property commonly distinguishes antimatter from its matter analogue?

a. mass
b. charge
c. energy
d. speed

9.

Can the Standard Model change as new information is gathered?

a. yes
b. no

10.

What is the relationship between the Higgs field and the Higgs boson?

a. The Higgs boson is the carrier that transfers force for the Higgs field.

b. The Higgs field is the time duration over which the Higgs particles transfer force to the other particles.
c. The Higgs field is the magnitude of momentum transferred by the Higgs particles to the other particles.
d. The Higgs field is the magnitude of torque transfers by the Higgs particles on the other particles.

11.

What were the original three flavors of quarks discovered?

a. up, down, and charm
b. up, down, and bottom
c. up, down, and strange
d. up, down, and top

12.

Protons are more massive than electrons. The three quarks in the proton account for only a small amount of this mass difference. What accounts for the remaining excess mass in protons compared to electrons?

a. The highly energetic gluons connecting the quarks account for the remaining excess mass in protons compared to electrons.
b. The highly energetic photons connecting the quarks account for the remaining excess mass in protons compared to electrons.
c. The antiparallel orientation of the quarks present in a proton accounts for the remaining excess mass in protons compared to electrons.
d. The parallel orientation of the quarks present in a proton accounts for the remaining excess mass in protons compared to electrons.

23.3 The Unification of Forces 13.

Why is the unification of fundamental forces important?

a. The unification of forces will help us understand fundamental structures of the universe.
b. The unification of forces will help in the proof of the graviton.
c. The unification of forces will help in achieving a speed greater than the speed of light.
d. The unification of forces will help in studying antimatter particles.

14.

Why are scientists unable to model the conditions of the universe at time periods shortly after the Big Bang?

a. The amount of energy necessary to replicate the Planck Epoch is too high.
b. The amount of energy necessary to replicate the Planck Epoch is too low.
c. The volume of setup necessary to replicate the Planck Epoch is too high.
d. The volume of setup necessary to replicate the Planck Epoch is too low.

15.

What role does proton decay have in the search for GUTs?

a. Proton decay is a premise of a number of GUTs.
b. Proton decay negates the validity of a number of GUTs.

16.

What is the name for the theory of unification of all four fundamental forces?

a. the theory of everything
b. the theory of energy-to-mass conversion
c. the theory of relativity
d. the theory of the Big Bang

17.

Is it easier for scientists to find evidence for the Grand Unified Theory or the Theory of Everything? Explain.

a. Theory of Everything, because it requires 10^{19}\,\text{GeV} of energy
b. Theory of Everything, because it requires 10^{14}\,\text{GeV} of energy
c. Grand Unified Theory, because it requires 10^{19}\,\text{GeV} of energy
d. Grand Unified Theory, because it requires 10^{14}\,\text{GeV} of energy