Critical Thinking Items

23.1 The Four Fundamental Forces 18.

The gravitational force is considered a very weak force. Yet, it is strong enough to hold Earth in orbit around the Sun. Explain this apparent disparity.

a. At the level of the Earth-to-Sun distance, gravity is the strongest acting force because neither the strong nor the weak nuclear force exists at this distance.
b. At the level of the Earth-to-Sun distance, gravity is the strongest acting force because both the strong and the weak nuclear force is minimal at this distance.

19.

True or False—Given that their carrier particles are massless, some may argue that the electromagnetic and gravitational forces should maintain the same value at all distances from their source. However, both forces decrease with distance at a rate of $\frac{1}{r}$

a. false
b. true

20.

Why is a stationary target considered inefficient in a particle accelerator?

a. The stationary target recoils upon particle strike, thereby transferring much of the particle's energy into its motion. As a result, a greater amount of energy goes into breaking the particle into its constituent components.
b. The stationary target contains zero kinetic energy, so it requires more energy to break the particle into its constituent components.
c. The stationary target contains zero potential energy, so it requires more energy to break the particle into its constituent components.
d. The stationary target recoils upon particle strike, transferring much of the particle's energy into its motion. As a result, a lesser amount of energy goes into breaking the particle into its constituent components.

21.

Compare the total strong nuclear force in a lithium atom to the total strong nuclear force in a lithium ion (\text{Li}^{+1}).

a. The total strong nuclear force in a lithium atom is thrice the total strong nuclear force in a lithium ion.
b. The total strong nuclear force in a lithium atom is twice the total strong nuclear force in a lithium ion.
c. The total strong nuclear force in a lithium atom is the same as the total strong nuclear force in a lithium ion.

d. The total strong nuclear force in a lithium atom is half the total strong nuclear force in a lithium ion.

23.2 Quarks 22.

Explain why it is not possible to find a particle composed of just two quarks.

a. A particle composed of two quarks will have an integral charge and a white color. Hence, it cannot exist.
b. A particle composed of two quarks will have an integral charge and a color that is not white. Hence, it cannot exist.
c. A particle composed of two quarks will have a fractional charge and a white color. Hence, it cannot exist.
d. A particle composed of two quarks will have a fractional charge and a color that is not white. Hence, it cannot exist.

23.

Why are mesons considered unstable?

a. Mesons are composites of two antiparticles that quickly annihilate each other.
b. Mesons are composites of two particles that quickly annihilate each other.
c. Mesons are composites of a particle and antiparticle that quickly annihilate each other.
d. Mesons are composites of two particles and one antiparticle that quickly annihilate each other.

24.

Does antimatter have a negative mass?

a. No, antimatter does not have a negative mass.
b. Yes, antimatter does have a negative mass.

25.

What similarities exist between the Standard Model and the periodic table of elements?

a. During their invention, both the Standard Model and the periodic table organized material by mass.
b. At the times of their invention, both the Standard Model and the periodic table organized material by charge.
c. At the times of their invention, both the Standard Model and the periodic table organized material by interaction with other available particles.
d. At the times of their invention, both the Standard Model and the periodic table organized material by size.

26.

How were particle collisions used to provide evidence of the Higgs boson?

a. Because some particles do not contain the Higgs boson, the collisions of such particles will cause their destruction.
b. Because only the charged particles contain the Higgs boson, the collisions of such particles will cause their destruction and will expel the Higgs boson.
c. Because all particles with mass contain the Higgs boson, the collisions of such particles will cause their destruction and will absorb the Higgs boson.
d. Because all particles with mass contain the Higgs boson, the collisions of such particles will cause their destruction and will expel the Higgs boson.

27.

Explain how the combination of a quark and antiquark can result in the creation of a hadron.

a. The combination of a quark and antiquark can result in a particle with an integer charge and color of white, therefore satisfying the properties for a hadron.
b. The combination of a quark and antiquark must result in a particle with a negative charge and color of white, therefore satisfying the properties for a hadron.
c. The combination of a quark and antiquark can result in a particle with an integer charge and color that is not white, therefore satisfying the properties for a hadron.
d. The combination of a quark and antiquark can result in particle with a fractional charge and color that is not white, therefore satisfying the properties for a hadron.

23.3 The Unification of Forces 28.

Why does the strength of the strong force diminish under high-energy conditions?

a. Under high-energy conditions, particles interacting under the strong force will be compressed closer together. As a result, the force between them will decrease.
b. Under high-energy conditions, particles interacting under the strong force will start oscillating. As a result, the force between them will increase.
c. Under high-energy conditions, particles interacting under the strong force will have high velocity. As a result, the force between them will decrease.
d. Under high-energy conditions, particles interacting under the strong force will start moving randomly. As a result, the force between them will decrease.

29.

If some unknown cause of the red shift, such as light becoming *tired* from traveling long distances through empty space, is discovered, what effect would there be on cosmology?

a. The effect would be substantial, as the Big Bang is based on the idea that the red shift is evidence that galaxies are moving toward one another.
b. The effect would be substantial, as the Big Bang is based on the idea that the red shift is evidence that the galaxies are moving away from one another.
c. The effect would be substantial, as the Big Bang is based on the idea that the red shift is evidence that galaxies are neither moving away from nor moving toward one another.
d. The effect would be substantial, as the Big Bang is based on the idea that the red shift is evidence that galaxies are sometimes moving away from and sometimes moving toward one another.

30.

How many molecules of water are necessary if scientists wanted to check the 10^{31}-yr estimate of proton decay within the course of one calendar year?

a. 10^{29}\, \text{molecules}
b. 10^{30}\,\text{molecules}
c. 10^{31}\, \text{molecules}
d. 10^{32}\, \text{molecules}

31.

As energy of interacting particles increases toward the theory of everything, the gravitational force between them increases. Why does this occur?

a. As energy increases, the masses of the interacting particles will increase.
b. As energy increases, the masses of the interacting particles will decrease.
c. As energy increases, the masses of the interacting particles will remain constant.
d. As energy increases, the masses of the interacting particles starts changing (increasing or decreasing). As a result, the gravitational force between the particles will increase.