Physics 107: Ideas of Modern Physics

Exam 4
May 11, 2007

Name______________________________________________________
ID #_________________________               Section #______________

On the Scantron sheet,
1) Fill in your name
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Fundamental constants:
c = speed of light = 3x10^8 m/s
\( g = \) accel. of gravity on Earth = 10 m/s^2
\( G = \) gravitational constant = 6.7x10^{-11} N-m^2/kg^2

1 eV = 1.6 x 10^{-19} Joules
Photon energy \( E = \frac{hc}{\lambda} = 1240 \text{ eV-nm}/\lambda \).
1. B

2. Which of the following is true of fusion
   a. Fusion is induced by neutron absorption
   b. Fusion reactors provide part of the energy consumed in this country.
   c. Only light elements are used as fuel in fusion reactors
   d. The daughter products of fusion are lighter than the initial nuclei.
   e. The idea of fusion was developed only ten years ago.

3. About 1 MeV ($10^6$ eV) of energy per nucleon is released during the fission of $^{235}$U. About how many $^{235}$U nuclei per second (there are many nucleons in a nucleus) fission in a reactor that produces 50 mega-watts ($50 \times 10^6$ Watts) of power?
   a. $1.3 \times 10^{18}$ nuclei/sec
   b. $50 \times 10^6$ nuclei/sec
   c. $1.2 \times 10^{12}$ nuclei/sec
   d. 0.2 nuclei/sec
   e. 170 nuclei/sec

4. In order for a particle to couple to the gluon field, it must have
   a. flavor
   b. mass
   c. color charge
   d. electric charge
   e. all of the above

5. An electron and a positron are at rest, and each separately have a mass of 0.5 MeV/c$^2$ ($1$ MeV = $10^6$ eV). They annihilate to produce two photons. Each photon has a wavelength of
   a. 0.005 nm
   b. 0.0025 nm
   c. 0.5 nm
   d. $2.5 \times 10^3$ nm
   e. 2.5 nm
6. Which of these fundamental particles is not a matter particle
   a. gluon
   b. electron
   c. tau
   d. muon
   e. all of them are

7. A proton is a composite particle consisting of three up and down quarks, (up charge = +2/3e, and down charge = -1/3e). Which is the quark structure of the proton?
   a. up, up, down
   b. up, up, up
   c. down, down, down
   d. up, down, down
   e. none of these

8. The force that binds together quarks into hadrons is
   a. Gravitational force
   b. Electromagnetic force
   c. Strong force
   d. Weak force
   e. none of these

9. In the Ice Cube neutrino telescope, neutrinos can be detected because they change into muons in the Antarctic ice. The interaction responsible for this is
   a. the weak interaction
   b. the strong interaction
   c. the gravitational interaction
   d. the electromagnetic interaction
   e. none of these

10. Which of these particles represents an excited state of the weak interaction field?
    a. tau
    b. neutrino
    c. photon
    d. top quark
    e. W'
11. Which of these particles does not mediate a fundamental force?

a. photon  
b. gluon  
c. muon  
d. W  
e. all of them do

12. In quantum field theory, two particles interact only when

a. both particles have electric charge  
b. a mediating field is excited  
c. the probabilities are uncertain  
d. one of the particles is moving  
e. one of the particles is a muon

13. Which of the following interactions can change one fundamental particle into another?

a. Weak interaction  
b. Strong interaction  
c. Electromagnetic interaction  
d. Gravitational interaction  
e. none of these

14. How many generations of leptons and quarks are in the standard model?

a. 1  
b. 2  
c. 3  
d. 4  
e. 5

15. The difference between the different generations of leptons is

a. their color  
b. their charge  
c. their shape  
d. their spin  
e. their mass
16. Which of these particles do not interact via the electromagnetic force?
   a. neutrino
   b. electron
   c. quark
   d. tau
   e. they all do

17. Matter is made of
   a. quarks only
   b. leptons only
   c. quarks and leptons only
   d. gluons only
   e. quarks and gluons only

18. The standard model is modified by adding an extra field called the Higgs field, whose excitation is the Higgs boson. Coupling of fundamental particles to this field gives the particles
   a. mass
   b. charge
   c. color
   d. spin
   e. flavor

19. Strings interact
   a. by exchanging field particles
   b. via the strong interaction
   c. by changing color
   d. by joining and splitting
   e. by exchanging spin

20. In string theory, different fundamental particles appear as
   a. different quantum interactions between strings
   b. quantum strings of different color
   c. quantum strings of different length
   d. different quantum vibrations of strings.
   e. quantum strings of different velocity

21. Particle physics is important in understanding the big bang because
   a. the big bang was very loud
   b. time passed quickly at big bang
   c. energies were extremely high at big bang
   d. black holes dominated the big bang
   e. long time has passed since big bang occurred