19. Why is the temperature required for deuterium-tritium fusion lower than that needed for deuterium-deuterium fusion? (Hint: Consider the Coulomb repulsion and nuclear attraction for each case.)

Practice Problems

For problems 20–21, see Sample Problem B.

20. Determine the product of the following reaction:
$^{7}_{3}\text{Li} + {}^{4}_{2}\text{He} \rightarrow ? + {}^{1}_{0}n$

21. Complete the following nuclear reactions:

a. $? + {}^{14}_{7}\text{N} \rightarrow {}^{1}_{1}\text{H} + {}^{17}_{8}\text{O}$

b. $^{7}_{3}\text{Li} + {}^{1}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + ?$

For problems 22–24, see Sample Problem C.

22. A radioactive sample contains 1.67×10^{11} atoms of $^{108}_{47}\text{Ag}$ (half-life = 2.42 min) at some instant. Calculate the decay constant and the activity of the sample in mCi.

23. How long will it take a sample of polonium-210 with a half-life of 140 days to decay to one-sixteenth its original strength?

24. The amount of carbon-14 ($^{14}_{6}\text{C}$) in a wooden artifact is measured to be 6.25 percent the amount in a fresh sample of wood from the same region. The half-life of carbon-14 is 5715 years. Assuming the same amount of carbon-14 was initially present in the artifact, determine the age of the artifact.

PARTICLE PHYSICS

Review Questions

25. Describe the properties of quarks.

26. What is the electric charge of the particles with the following quark compositions?

a. udd

b. uud

c. $u\bar{d}$

27. What is the electric charge of the baryons with the following quark compositions?

a. $\bar{u}\bar{u}\bar{d}$

b. $\bar{u}\bar{d}\bar{d}$

28. What are each of the baryons in item 27 called?

29. How many quarks or antiquarks are there in the following particles?

a. a baryon

b. an antibaryon

c. a meson

d. an antimeson

Conceptual Questions

30. Compare a neutrino with a photon.

31. Consider the statement, "All mesons are hadrons, but not all hadrons are mesons." Is this statement true? Explain.

MIXED REVIEW

32. Complete the following nuclear reaction:
$^{27}_{13}\text{Al} + {}^{4}_{2}\text{He} \rightarrow ? + {}^{30}_{15}\text{P}?$

33. Consider the hydrogen atom to be a sphere with a radius equal to the Bohr radius, 0.53×10^{-10} m, and calculate the approximate value of the ratio of atomic density to nuclear density.

34. Certain stars are thought to collapse at the end of their lives, combining their protons and electrons to form a neutron star. Such a star could be thought of as a giant atomic nucleus. If a star with a mass equal to that of the sun (1.99×10^{30} kg) were to collapse into neutrons, what would be the radius of the star?

35. Calculate the difference in binding energy for the two nuclei $^{15}_{8}\text{O}$ and $^{15}_{7}\text{N}$.

36. A piece of charcoal known to be approximately 25 000 years old contains 7.96×10^{10} C-14 atoms.

a. Determine the number of decays per minute expected from this sample. (The half-life of C-14 is 5715 years.)

b. If the radioactive background in the counter without a sample is 20.0 counts per minute and we assume 100.0 percent efficiency in counting, explain why 25 000 is close to the limit of dating with this technique.