1. What two subatomic particles make up the nucleus?
   a. proton and neutron
   b. neutron and electron
   c. electron and protons
   d. isotope and neutron

2. Which has the greatest number of protons in its nucleus?
   a. hydrogen
   b. iron
   c. lead
   d. uranium

3. When a gamma ray is emitted by a nucleus, the nucleus then has appreciably less
   a. mass
   b. charge
   c. both of these
   d. neither of these

4. Energy released by the Sun results from the process wherein atomic nuclei
   a. break apart
   b. combine
   c. both of these
   d. neither of these

5. A (an) __________ is the ordered display of the various "fingerprint" patterns of wavelengths (or frequencies) emitted or absorbed by a source
   a. energy level diagram
   b. electron cloud
   c. orbital
   d. spectrum

6. The half-life of a radioactive substance is
   a. half the amount of time needed for a sample to decay completely
b. half the amount of time a sample can be kept before it begins to decay
c. the amount of time needed for half of a sample to decay
d. the amount of time needed for the remainder of a sample to decay after half of it has already decays

(3) 7. How is the atomic number of an element defined?
a. the number of protons in the atom's nucleus
b. the number of neutrons in the atom's nucleus
c. the number of electrons minus the number of protons
d. the total mass of all the particles

(3) 8. Which radiation has the most mass associated with it?
a. $\alpha$ (alpha)
b. $\beta$ (beta)
c. $\gamma$ (gamma)
d. electron

(3) 9. The number of neutrons in the nucleus of the lead isotope Fe-56 is
   a. 26
   b. 56
   c. 55
   d. 30

(3) 10. Which color of light comes from the higher energy transition?
   a. violet
   b. red
   c. yellow
   d. orange

(3) 11. Carbon dating requires that the object being tested contains
   a. organic material
   b. charcoal
   c. sugar molecules
   d. radioactive uranium

(3) 12. In the fission of uranium, a chain reaction is caused by
   a. the enormous energy release
   b. the kinetic energy of the decay product
   c. ejected neutrons
   d. the conversion of mass to energy

(3) 13. If a proton is added to an carbon nucleus, the result is
   a. nitrogen
b. oxygen
  c. beryllium
  d. helium

(3) 14. The Bohr model of the atom is akin to a
  a. miniature solar system
  b. blob of plum pudding, where raisins represent atomic nuclei
  c. central heavy ball with lighter balls connected by springs
  d. thin gold foil

(3) 15. In nuclear fusion
  a. an initial reaction triggers a series of subsequent reactions
  b. light nuclei combine to form a heavier nucleus
  c. a heavy nucleus is split into lighter ones
  d. protons are converted into neutrons

(3) 16. When uranium-235 undergoes fission, the two nuclei that result
      have a total of
  a. 92 protons
  b. 90 protons
  c. more than 92 protons
  d. 91 protons

(3) 17. The number of protons in the nucleus of the lead isotope  Fe-56 is
  a. 26
  b. 56
  c. 55
  d. 30

(3) 18. The product nucleus resulting from a decay of alpha or beta
      particles is that of a
  a. transmuted version of the same element
  b. an ion of the same element
  c. completely different element
  d. different isotope of the same element

(3) 19. Which radiation has positive electric charge associated with it?
  a. α (alpha)
  b. β (beta)
  c. γ (gamma)
  d. electron

(3) 20. Which of these phenomena specifically demonstrate the existence
      of light quanta, or proton?
  a. refraction
b. dispersion

c. interference

d. the photoelectric effect

21. Why doesn't the uranium ore in mines spontaneously explode?

22. The age of the Dead Sea Scrolls was found by carbon dating. Could this technique have worked if they were carved in stone tablets? Explain.

23. Strontium-90 is a product of nuclear fission. It has a half-life of 28 years. How much Strontium-90 will be left from 32 tons of Strontium-90 residue in 140 years?

24. Supply the missing information for each equation
25. Which process would release energy from gold, fission or fusion? From carbon? From iron?

\[ ^{206}_{82}\text{Pb} 
\rightarrow 
\begin{array}{c}
\text{He} \\
^{4}_{2}
\end{array} 
\]

\[ ^{206}_{82}\text{Pb} 
\rightarrow 
\begin{array}{c}
\text{e} \\
^{0}_{-1}
\end{array} 
\]

(5) 26. Some people say that all things are possible. Is it at all possible for a hydrogen nucleus to emit an alpha particle? Defend your answer.

(5) 27. Match the correct answer

- Critical mass
- Beta rays

A. Conversion of a radioactive nucleus to totally different kind of nucleus by emission of \( \alpha \) and \( \beta \) particles

B. The nature of light that behaves as both waves and as particles
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<thead>
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<tbody>
<tr>
<td>A</td>
<td>Atomic mass number</td>
<td>C. Negatively charged electrons</td>
</tr>
<tr>
<td>B</td>
<td>Transmutation</td>
<td>D. The smallest amount of fissionable material required for chain reaction</td>
</tr>
<tr>
<td>C</td>
<td>wave-particle duality</td>
<td>E. The total number of nucleons in the nucleus of an atom</td>
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BONUS: 5 POINTS
About how old are the atoms that make up the body of an 18-year-old student? Explain your answer.