MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

The image below shows a beam of radiation passing between two electrically charged plates.

1) Which of the beams is due to a high energy electron?  
   A) a  
   B) b  
   C) c  
   D) all of the above  
   E) none of the above

2) Which of the beams is due to alpha particles?  
   A) a  
   B) b  
   C) c  
   D) all of the above  
   E) none of the above

3) Which of the beams is actually composed of particles?  
   A) a  
   B) b  
   C) c  
   D) a and c  
   E) all of the above

4) Which of the beams is due to an energetic light wave?  
   A) a  
   B) b  
   C) c  
   D) all of the above  
   E) none of the above
5) Rank the following by the relative amounts of energy, from most energetic to least:
   A) cosmic rays, blue light, red light, radio waves
   B) blue light, red light, radio waves, cosmic rays
   C) red light, radio waves, blue light, cosmic rays
   D) radio waves, cosmic rays, blue light, red light
   E) cosmic rays, radio waves, blue light, red light

6) How do fission power plants work?
   A) The krypton gas generated in the fission process is used to drive a turbine.
   B) The neutrons from a nuclear reaction undergo fusion with water to produce hydrogen gas, which drives a turbine.
   C) The electrons from a nuclear reaction are harnessed to produce an electrical current.
   D) The heat from a nuclear reaction is used to boil water.
   E) none of the above

7) Which of the following does not describe a neutron?
   A) It is much more massive than an electron.
   B) It is often associated with protons.
   C) It is more difficult to detect than a proton or an electron.
   D) It is a nucleon.
   E) It has a positive charge equivalent but opposite of an electron's.

8) What is a half-life?
   A) It is half of the lifetime of the radioactivity in a sample.
   B) It is the time it takes for 1/2 of the material to undergo radiodecay.
   C) It is the time it takes for 1/2 of the material to decompose.
   D) It is the time needed until 1/2 of the radiation is gone.
   E) all of the above

9) Visible light has a frequency range between $7 \times 10^{14}$ Hz and $4 \times 10^{14}$ Hz. Which frequency of light would have the most energy?
   A) $4 \times 10^{14}$ Hz
   B) $7 \times 10^{14}$ Hz
   C) Both have same energy.
   D) Energy is related to wavelength only, not frequency.
   E) none of the above

10) What does the following element description actually mean?

\[
\begin{array}{c}
238 \\
92
\end{array} U
\]

   A) a uranium atom with 238 neutrons and 92 protons
   B) a uranium atom with 92 neutrons and 238 protons
   C) a uranium atom with 92 protons and 146 neutrons
   D) a uranium atom with 92 neutrons and 146 protons
   E) none of the above
11) Which of the following is a property of light?
   A) It is a particle.
   B) Its energy comes in packets of uniform size.
   C) It is a wave.
   D) all of the above
   E) none of the above

12) How can a hydrogen atom, which has only one electron, have so many spectral lines?
   A) One electron can be boosted to many different energy levels.
   B) The electron is able to move at various speeds.
   C) The atomic radius of the hydrogen atom is relatively large.
   D) The protons in the nucleus are also giving off various light frequencies.

13) Which of the following statements best describes an element?
   A) a material with more than one type of atom
   B) a material that has consistent chemical properties
   C) a material that has consistent physical properties
   D) a material that is pure
   E) a material consisting of only one type of atom

14) In what sense can you truthfully say that you are a part of every person around you?
   A) We are continually exchanging our atoms.
   B) There are more people alive now than have ever lived.
   C) We all live on the same planet and share the same resources.
   D) We all share the same genetic code.

15) Using the following generic atom description, choose the correct method for determining the
    number of neutrons.

\[
\begin{array}{c}
F \\
X \\
G
\end{array}
\]

A) subtract F from G
B) subtract G from F
C) divide F by G
D) add F and G
E) look it up on the periodic table

16) What is the purpose of a spectroscope?
   A) It segregates light by the different amounts of energy it contains.
   B) It separates light into its different frequencies.
   C) It separates light into its different wavelengths.
   D) all of the above
   E) It is used to measure the length of specs.

17) If you remove two protons and two neutrons from a gold atom (Au), what new element is formed
    (if any)?
   A) Au\textsuperscript{2+}  B) Ir  C) Au  D) Re  E) Tl
18) Does it make sense to say that a textbook is about 99.9 percent empty space?
   A) No. A textbook is a solid and thus is quite dense. Therefore it is not 99.9 percent empty space.
   B) Yes. A textbook like all material things is made up of atoms, which are considered to be 99.9 percent empty space.
   C) No. A textbook could only be considered to be 99.9 percent empty space if it were combusted.
   D) No. Only gases are considered to be 99.9 percent empty space. Liquids and solids are not.

19) Which process would release energy from gold, fission or fusion? From carbon?
   A) gold: fusion; carbon: fission  
   B) gold: fission; carbon: fusion  
   C) gold: fusion; carbon: fusion  
   D) gold: fission; carbon: fission

20) How would you describe light generated by heating pure elements if it was observed through a prism or spectroscope?
   A) You would see a series of very sharp lines of emitted light.
   B) You would see one line of emitted light, but it would be different for each element.
   C) Light is absorbed by heated elements so you would not see anything.
   D) You would see a rainbow of colors.
   E) none of the above

21) Why are the atomic masses listed in the periodic table not whole numbers?
   A) That would be too much of a coincidence.
   B) Scientists have yet to make the precise measurements.
   C) Today's instruments are able to measure the atomic masses to many decimal places.
   D) The atomic masses are average atomic masses.

22) What does the following element description actually mean?

   \textit{hydrogen-2}
   A) a hydrogen with two neutrons
   B) a hydrogen with one neutron and one proton
   C) a hydrogen with two protons
   D) a molecule of hydrogen gas
   E) two hydrogen atoms

23) If a neutral element has the following chemical symbol, how many electrons does it have?

   \text{\textsuperscript{18} O}
   A) 6
   B) 24
   C) 12
   D) 18
   E) none of the above

24) Which of the following statements about carbon-14 dating is true?
   A) Carbon-14 dating can be used to date stone tools as well as bone.
   B) Carbon-14 can be used to date anything younger than 50,000 years.
   C) Carbon-14 dating is very accurate because the amount of carbon-14 in the atmosphere is constant.
   D) all of the above
   E) none of the above
25) Which of the following statements describes an isotope?
   A) element with the same number of protons but a different number of neutrons
   B) element with the same number of neutrons but a different number of electrons
   C) element with the same number of protons but a different number of electrons
   D) element with the same number of neutrons but a different number of protons
   E) none of the above

26) Why can’t we see atoms?
   A) We see with light energy but the atoms absorb all the light and therefore there are no reflections.
   B) We see with light energy and the wavelength is larger than the object and so it is not reflected.
   C) We cannot see things that are microscopic.
   D) Atoms are invisible.
   E) Atoms do not interact with light energy and therefore we are unable to observe them with light.

27) What does Einstein's energy equation (E = mc²) say about the energy that is derived from nuclear fission reactions?
   A) The energy released is due to the missing mass of the products compared to the mass of the starting materials.
   B) The energy is derived from the light that is emitted when the atom splits.
   C) The energy equation does not apply towards fission, only fusion.
   D) The energy is proportional to the mass of the atom undergoing fission.
   E) none of the above

28) If an element has 9 protons and 10 neutrons and 9 electrons, which expression correctly identifies the element?
   A) ¹⁹²⁺ F  B) ⁹¹⁹ F  C) ¹⁹⁹ K  D) ¹⁹¹⁹ K  E) ⁹¹⁹ K

29) Which are older, the atoms in the body of an elderly person or those in the body of a baby?
   A) an elderly person because they have been around much longer
   B) It depends upon their diet.
   C) They are of the same age, which is appreciably older than the solar system.
   D) a baby because this is surely a trick question

30) Which of the following statements does not describe a proton?
   A) It has a positive charge equivalent but opposite of an electron’s.
   B) It is a nucleon.
   C) It is much more massive than an electron.
   D) It orbits around the nucleus of an atom.
   E) It is attracted to negatively charged electrical plates.

31) What was Niels Bohr’s explanation for the observation of atomic spectra?
   A) Any photon could excite an electron.
   B) Electrons could not move in an atom.
   C) Nucleons could be excited by different electron energies.
   D) Only certain photons with the correct energy could excite the quanta in the nucleus.
   E) Electrons could only move in discrete energy steps within an atom.
32) If a material has a half-life of 24 hours, how long do you have to wait until the amount of radioisotope is 1/4 its original amount?
   A) 24 hours
   B) 12 hours
   C) 72 hours
   D) 48 hours
   E) practically forever, but it may be safe by then

33) Which of the following elements is the most stable from a nuclear point of view?
   A) argon
   B) iron
   C) hydrogen
   D) uranium
   E) All are equally stable.

34) Which element has the atomic number 9?
   A) Na
   B) Be
   C) F
   D) Ne
   E) B

35) What does the following element description actually mean?
   **iron–57**
   A) an iron with an atomic number of 57
   B) an iron with a mass number of 57
   C) an iron with 57 neutrons
   D) an iron with 57 protons
   E) 57 iron atoms
1) A  
2) C  
3) D  
4) B  
5) A  
6) D  
7) E  
8) B  
9) B  
10) C  
11) D  
12) A  
13) E  
14) A  
15) B  
16) D  
17) B  
18) B  
19) B  
20) A  
21) D  
22) B  
23) A  
24) E  
25) A  
26) B  
27) A  
28) A  
29) C  
30) D  
31) E  
32) D  
33) B  
34) C  
35) B