**Name** **Modern: Atoms & Spectra**

1. During a collision between a photon and an electron, there is conservation of

   A) energy, only
   B) momentum, only
   C) both energy and momentum
   D) neither energy nor momentum

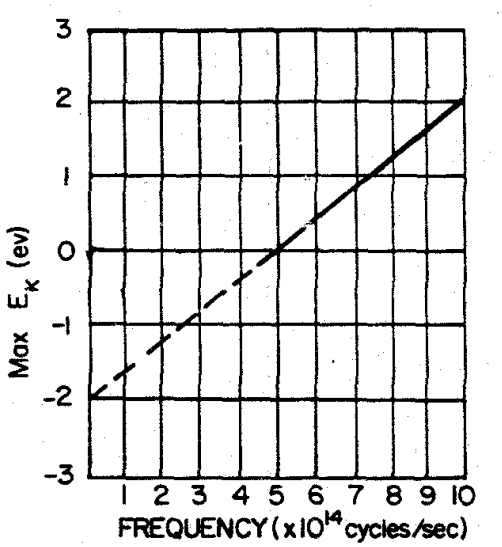
2. As a photon loses energy during a collision, its wavelength

   A) decreases B) increases
   C) remains the same

3. The momentum of a photon is inversely proportional to the photon's

   A) frequency B) mass
   C) weight D) wavelength

4. Base your answer to the following question on the graph below which represents the relationship between the maximum kinetic energy of emitted photoelectrons and the frequencies of the photons incident upon a photoemissive surface.




   As the frequency of the incident photons decreases, their momentum

   A) decreases B) increases
   C) remains the same

5. Compared to the photon momentum of blue light the photon momentum of red light is

   A) less B) greater
   C) the same

6. On the atomic level, energy and matter exhibit the characteristics of

   A) particles, only
   B) waves, only
   C) neither particles nor waves
   D) both particles and waves

7. According to the theory of matter waves, as the momentum of a particle increases, its wavelength

   A) decreases B) increases
   C) remains the same

8. If the wave properties of a particle are difficult to observe, it is probably due to the particle's

   A) small size B) large mass
   C) low momentum D) high charge

9. Which of the following would best illustrate the wave properties of matter?

   A) photoelectric effect
   B) diffraction of electrons
   C) alpha particle scattering
   D) photon-particle collisions

10. Compared to a proton, an alpha particle has

    A) the same mass and twice the charge
    B) twice the mass and the same charge
    C) twice the mass and four times the charge
    D) four times the mass and twice the charge

11. Base your answer to the following question on the Rutherford gold foil scattering experiments.

    An alpha particle is a

    A) positron B) deuteron
    C) gold nucleus D) helium nucleus

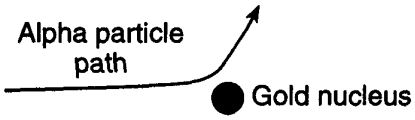
12. Which type of force causes the hyperbolic trajectory of alpha particles in Rutherford's scattering experiment?

    A) gravitational B) electrostatic
    C) magnetic D) nuclear

13. What is the minimum energy needed to ionize a hydrogen atom in the n = 2 energy state?

    A) 13.6 eV B) 10.2 eV
    C) 3.40 eV D) 1.89 eV

14. The diagram below represents the hyperbolic path of an alpha particle as it passes very near the nucleus of a gold atom.




The shape of the path is caused by the force between the

A) positively charged alpha particle and the neutral nucleus
B) positively charged alpha particle and the positively charged nucleus
C) negatively charged alpha particle and the neutral nucleus
D) negatively charged alpha particle and the positively charged nucleus

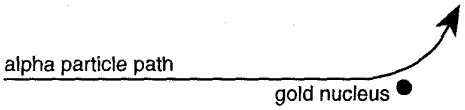
15. Rutherford performed "scattering" experiments by bombarding thin gold foil with alpha particles. Which conclusion is supported by the results of his experiments?

A) Most of an atom's mass occupies a very small portion of its volume
B) The emission of light by electrons must be quantized.
C) Alpha particles are deflected into parabolic paths.
D) Electrons circling the nucleus of an atom cannot emit energy.

16. Rutherford observed that most of the alpha particles directed at a metallic foil appear to pass through unhindered, with only a few deflected at large angles. What did he conclude?

A) Alpha particles behave like waves when they interact with atoms.
B) Atoms have most of their mass distributed loosely in an electron cloud.
C) Atoms can easily absorb and reemit alpha particles.
D) Atoms consist mainly of empty space and have small, dense nuclei.

17. Which diagram shows a possible path of an alpha particle as it passes very near the nucleus of a gold atom?

A)
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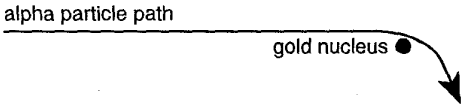


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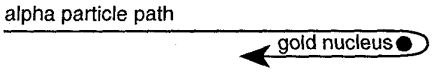
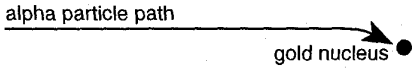



D)



18. In the currently accepted model of the atom, a fuzzy cloud around a hydrogen nucleus is used to represent the

A) electron's actual path, which is not a circular orbit
B) general region where the atom's proton is most probably located
C) general region where the atom's electron is most probably located
D) presence of water vapor in the atom

19. In his model of the atom, Bohr assumed that the electrons

A) are distributed evenly throughout the atom
B) are located only in the nucleus of the atom
C) are located only in a limited number of specified orbits
D) emit energy while in orbit

20. An electron in a mercury atom drops from energy level *f to energy level c by emitting a photon having an energy of*

A) 8.20 eV B) 5.52 eV
C) 2.84 eV D) 2.68 eV

21. Base your answer to the following question on the statement below.

The spectrum of visible light emitted during transitions in excited hydrogen atoms is composed of blue, green, red, and violet lines.

Which color of light in the visible hydrogen spectrum has photons of the shortest wavelength?

A) blue B) green C) red D) violet

22. A photon having an energy of 9.40 electronvolts strikes a hydrogen atom in the ground state. Why is the photon *not* absorbed by the hydrogen atom?

    A) The atom's orbital electron is moving too fast.
    B) The photon striking the atom is moving too fast.
    C) The photon's energy is too small.
    D) The photon is being repelled by electrostatic force.

23. Which type of photon is emitted when an electron in a hydrogen atom drops from the $n = 2$ to the $n = 1$ energy level?

    A) ultraviolet  B) visible light
    C) infrared  D) radio wave

24. A hydrogen atom with an electron initially in the $n = 2$ level is excited further until the electron is in the $n = 4$ level. This energy level change occurs because the atom has

    A) absorbed a 0.85-eV photon
    B) emitted a 0.85-eV photon
    C) absorbed a 2.55-eV photon
    D) emitted a 2.55-eV photon

25. White light is passed through a cloud of cool hydrogen gas and then examined with a spectroscope. The dark lines observed on a bright background are caused by

    A) the hydrogen emitting all frequencies in white light
    B) the hydrogen absorbing certain frequencies of the white light
    C) diffraction of the white light
    D) constructive interference

26. The electron in a hydrogen atom drops from energy level $n = 2$ to energy level $n = 1$ by emitting a photon having an energy of approximately

    A) $5.4 \times 10^{-19}$ J  B) $1.6 \times 10^{-18}$ J
    C) $2.2 \times 10^{-18}$ J  D) $7.4 \times 10^{-18}$ J

27. A mercury atom in the ground state absorbs 20.00 electronvolts of energy and is ionized by losing an electron. How much kinetic energy does this electron have after the ionization?

    A) 6.40 eV  B) 9.62 eV
    C) 10.38 eV  D) 13.60 eV

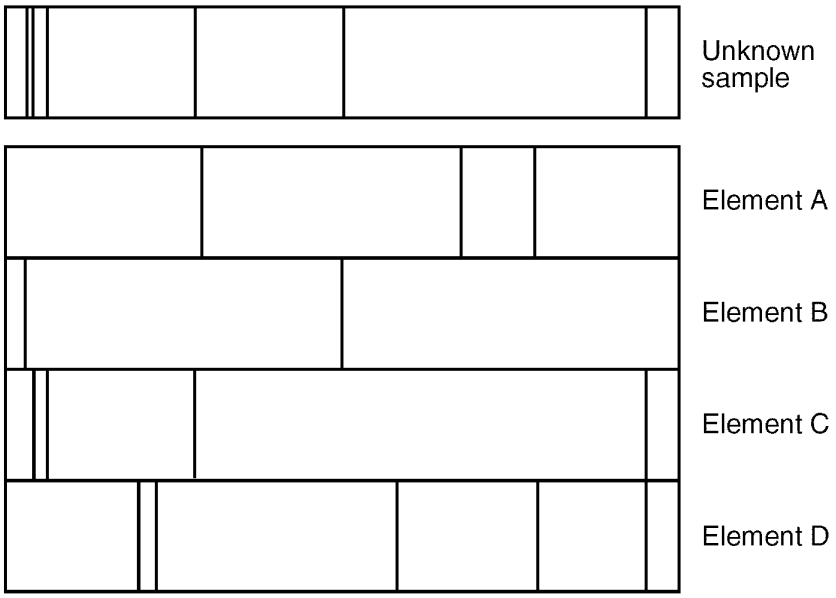
28. How much energy is required to move an electron in a mercury atom from the ground state to energy level $h$?

    A) 1.57 eV  B) 8.81 eV
    C) 10.38 eV  D) 11.95 eV

29. An excited atom emits a photon of energy E when an electron changes from energy level n = 3 to n = 2. In order for the same electron to change directly from energy level n = 2 to n = 3, it may

    A) absorb a photon with energy E
    B) absorb a photon with energy 2E
    C) emit a photon with energy 3E
    D) emit a photon with energy E/2

30. The diagram below represents the bright-line spectra of four elements, *A*, *B*, *C*, and *D*, and the spectrum of an unknown gaseous sample.




Based on comparisons of these spectra, which two elements are found in the unknown sample?

A) *A* and *B* B) *A* and *D* C) *B* and *C* D) *C* and *D*