

Conceptual Questions

30.1 Discovery of the Atom

1.

Name three different types of evidence for the existence of atoms.

2.

Explain why patterns observed in the periodic table of the elements are evidence for the existence of atoms, and why Brownian motion is a more direct type of evidence for their existence.

3.

If atoms exist, why can't we see them with visible light?

30.2 Discovery of the Parts of the Atom: Electrons and Nuclei

4.

What two pieces of evidence allowed the first calculation of m_e , the mass of the electron?

(a) The ratios q_e/m_e and q_p/m_p .

(b) The values of q_e and E_B .

(c) The ratio q_e/m_e and q_e .

Justify your response.

5.

How do the allowed orbits for electrons in atoms differ from the allowed orbits for planets around the sun? Explain how the correspondence principle applies here.

30.3 Bohr's Theory of the Hydrogen Atom

6.

How do the allowed orbits for electrons in atoms differ from the allowed orbits for planets around the sun? Explain how the correspondence principle applies here.

7.

Explain how Bohr's rule for the quantization of electron orbital angular momentum differs from the actual rule.

8.

What is a hydrogen-like atom, and how are the energies and radii of its electron orbits related to those in hydrogen?

30.4 X Rays: Atomic Origins and Applications

9.

Explain why characteristic x rays are the most energetic in the EM emission spectrum of a given element.

10.

Why does the energy of characteristic x rays become increasingly greater for heavier atoms?

11.

Observers at a safe distance from an atmospheric test of a nuclear bomb feel its heat but receive none of its copious x rays. Why is air opaque to x rays but transparent to infrared?

12.

Lasers are used to burn and read CDs. Explain why a laser that emits blue light would be capable of burning and reading more information than one that emits infrared.

13.

Crystal lattices can be examined with x rays but not UV. Why?

14.

CT scanners do not detect details smaller than about 0.5 mm. Is this limitation due to the wavelength of x rays? Explain.

30.5 Applications of Atomic Excitations and De-Excitations

15.

How do the allowed orbits for electrons in atoms differ from the allowed orbits for planets around the sun? Explain how the correspondence principle applies here.

16.

Atomic and molecular spectra are discrete. What does discrete mean, and how are discrete spectra related to the quantization of energy and electron orbits in atoms and molecules?

17.

Hydrogen gas can only absorb EM radiation that has an energy corresponding to a transition in the atom, just as it can only emit these discrete energies. When a spectrum is taken of the solar corona, in which a broad range of EM wavelengths are passed through very hot hydrogen gas, the absorption spectrum shows all the features of the emission spectrum. But when such EM radiation passes

through room-temperature hydrogen gas, only the Lyman series is absorbed. Explain the difference.

18.

Lasers are used to burn and read CDs. Explain why a laser that emits blue light would be capable of burning and reading more information than one that emits infrared.

19.

The coating on the inside of fluorescent light tubes absorbs ultraviolet light and subsequently emits visible light. An inventor claims that he is able to do the reverse process. Is the inventor's claim possible?

20.

What is the difference between fluorescence and phosphorescence?

21.

How can you tell that a hologram is a true three-dimensional image and that those in 3-D movies are not?

30.6 The Wave Nature of Matter Causes Quantization

22.

How is the de Broglie wavelength of electrons related to the quantization of their orbits in atoms and molecules?

30.7 Patterns in Spectra Reveal More Quantization

23.

What is the Zeeman effect, and what type of quantization was discovered because of this effect?

30.8 Quantum Numbers and Rules

24.

Define the quantum numbers n , l , m_l , s , and m_s .

25.

For a given value of n , what are the allowed values of l ?

26.

For a given value of l , what are the allowed values of m_l ? What are the allowed values of m_l for a given value of n ? Give an example in each case.

27.

List all the possible values of s and m_s for an electron. Are there particles for which these values are different? The same?

30.9 The Pauli Exclusion Principle

28.

Identify the shell, subshell, and number of electrons for the following: (a) $2p^3$. (b) $4d^9$. (c) $3s^1$. (d) $5g^{16}$.

29.

Which of the following are not allowed? State which rule is violated for any that are not allowed. (a) $1p^3$ (b) $2p^8$ (c) $3g^{11}$ (d) $4f^2$