

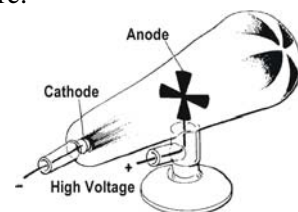
Test Review No 3

Early Theories of Matter. **Democritus (Greek Philosopher ~460 BC)** proposed all that matter is composed of particles called atoms (Greek for “uncuttable”). He envisioned atoms of different substances as having different geometric shapes. The idea did not gain acceptance. **Aristotle** proposed that there were four elements: earth; air; fire; and water. This idea gained acceptance because substances appeared to have different degrees of each of these building blocks. For example, a burning, green stick releases smoke (air), water, and ash (earth), and since it burns, it obviously contains fire. The Aristotelian view lasted for almost 2,000 years.

Modern Theories of Matter.

Dalton's Atomic Theory. Dalton proposed atomic theory in 1803 to explain his observations about the relative masses of elements in a compound. Dalton's Postulates say: [1] Matter is made of small particles called atoms; [2] Atoms are indestructible. They cannot be created or destroyed during chemical or physical changes; [3] Atoms of an element are identical. They have the same mass; [4] Atoms of different elements have different masses; [5] Compounds are formed by combining atoms of different elements. The Dalton model of the atom is a solid, indivisible sphere.

Thomson's Model. Thomson showed that the beam of light in a Crookes tube was actually composed of negatively charged particles he called electrons. In order to account for the negatively charged particles in neutral matter, he assumed the rest of the atom was positively charged. Thomson's model of the atom was a positively charged cloud with the negative electrons scattered evenly throughout.



Rutherford's Model. Ernest Rutherford performed the alpha scattering experiment in 1911. He probed the inside of the atom by aiming small, positively charged particles called alpha particles at gold foil. Only 1 in 20,000 alpha particles bounced straight back or were deflected greatly. The rest went straight through the gold foil. Based on these observations, Rutherford suggested that the atom is mostly empty space with a small, positively charged center and negatively charged electrons revolving around the outside like planets around the sun.

The Bohr Model. Bohr developed a model of the atom with circular pathways for the electron. These pathways were at fixed distances from the nucleus. Electrons could be found only in these circular pathways. If an electron absorbed enough energy, it could jump up to another level, but it could never be found between levels. Inevitably, the electron lost energy and fell back down to a previous level, giving off the extra energy as a specific frequency of light. Bohr had a complex equation into which he could substitute simple numbers, integers such as 1, 2, or 3, and the equation predicted the frequencies of the light. These mystery numbers represented the energy levels of the electrons. Bohr's evidence for his model was the bright line spectra formed when electrons fell from the excited state back to the ground state.

Wave Mechanical Model. The Bohr model successfully explained the bright line spectra for hydrogen, but could not explain the spectra of atoms with more electrons. The wave mechanical model solved the problem. The wave mechanical model describes the location of electrons as their most probable location rather than as orbits with fixed radii. The regions where electrons are most probably found are called orbitals. An orbital can hold, at most, two electrons.

Location of electrons. Electrons are in regions of the atom known as orbitals, which are found in subdivisions of the principal energy levels called sublevels. There are up to seven principal energy levels designated by a quantum number, n , from 1 to 7. The maximum number of sublevels in a principal energy level is n , but none of the existing elements use more than 4 sublevels even in principal energy levels 5–7. Sublevels are designated by the letters s, p, d, and f, in increasing order of energy. Orbitals are regions within a sublevel where electrons of a given energy are likely to be found. There are a maximum of 2 electrons in an orbital. The number of orbitals within a sublevel varies in a predictable pattern. The number of orbitals within a sublevel and the maximum number of electrons is as follows:

Sublevel	s	p	d	f
Number of orbitals	1	3	5	7
Maximum Number of Electrons	2	6	10	14

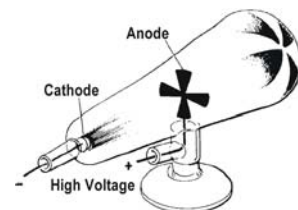
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Maximum number of electrons. As a result of the way the rules are applied for determining the maximum number of electrons per orbital, orbitals per sublevel, and sublevels per principal energy level, for any given principal energy level, n , the maximum number of orbitals is n^2 , and the maximum number of electrons is $2n^2$.

Principal Energy Level(n)	Number of Orbitals (n^2)	Electrons per Sublevel								Maximum Number of Electrons ($2n^2$)
		s	p	d	f	g	h	i		
		1	3	5	7	9	11	13		
Electrons in each Location	1	1	2	-	-	-	-	-	-	2
	2	4	2	6	-	-	-	-	-	8
	3	9	2	6	10	-	-	-	-	18
	4	16	2	6	10	14	-	-	-	32
	5	25	2	6	10	14	18	-	-	50
	6	36	2	6	10	14	18	22	-	72
	7	49	2	6	10	14	18	22	26	98

Answer the questions below by circling the number of the correct response

- In 1661, Robert Boyle proposed that matter is composed of simple substances called elements that cannot be broken down by chemical means. His theory was not accepted for over 100 years because (1) he lacked qualitative evidence, (2) he lacked quantitative evidence, (3) he lacked both qualitative and quantitative evidence, (4) he was a philosopher rather than a scientist.
- Boyle proposed that matter is composed of simple substances called elements that cannot be further decomposed or broken down. Aristotle's idea that air was an element did not fit Boyle's definition because air (1) cannot be seen, (2) cannot be broken down, (3) can be decomposed, (4) can react with other substances.
- Antoine Lavoisier measured the mass of some mercury. Then he heated it in air. The mercury turned into a red substance as it was heated. The mass of the red substance was greater than the mass of the mercury. The best explanation for this observation is that (1) matter was created, (2) a new element formed, (3) the mercury combined with something in the air, (4) hot mercury is heavier than cold mercury.
- Lavoisier heated mercury until a red substance formed. Then he heated the red substance and it broke down into mercury and oxygen. From his observations it is reasonable to conclude (1) mercury and oxygen are elements and the red substance is a compound composed of mercury and oxygen, (2) mercury, oxygen, and the red substance are elements, (3) the red substance is an element, and mercury and oxygen are compounds composed from it, (4) mercury, oxygen, and the red substance are compounds.
- When Lavoisier heated mercury II oxide, it decomposed into mercury and oxygen. The mass of the mercury II oxide was equal to the mass of the mercury plus the mass of the oxygen. This shows that during the chemical reaction (1) matter was not created but it was destroyed, (2) matter was created but it was not destroyed, (3) matter was both created and destroyed, (4) matter was neither created nor destroyed.
- An 18 kg sample of water is decomposed by electrolysis, releasing 16 kg of oxygen. How much hydrogen was released? (1) 34 kg (2) 2 kg (3) 16 kg (4) 1.125 kg
- If 46 g of X combines with 16 g of Y to form Z, how much Z is formed? (1) 30 g (2) 2.9 g (3) 724 g (4) 62 g
- When William Crookes passed current through a cathode (negative electrode) in a glass vacuum tube, the tube glowed casting a shadow of the anode at the opposite end as shown in the diagram at the right. This showed Crookes that the source of the light was the (1) anode, (2) cathode, (3) protons, (4) neutrons.
- Modern atomic theory is based on the work of (1) Kepler, (2) Aristotle, (3) Dalton, (4) Leeuwenhoek.
- Which particles have the smallest mass? (1) electrons (2) protons (3) neutrons (4) atoms
- Dalton's model of the atom was (1) a solid sphere, (2) a positive cloud with scattered electrons, (3) the "solar system" model, (4) based on electrons moving in fixed circular pathways around the nucleus
- Who made the discovery that cathode rays were actually negatively charged particles called electrons? (1) Thomson, (2) Bohr, (3) Rutherford, (4) Dalton
- Whose model of the atom could be represented by a solid, indivisible sphere with a characteristic mass? (1) Dalton (2) Thomson (3) Rutherford (4) Bohr
- Whose model of the atom could be represented by a positively charged cloud with electrons distributed through it? (1) Dalton (2) Thomson (3) Rutherford (4) Bohr
- The nucleus of the atom was discovered by (1) Thomson, (2) Bohr, (3) Rutherford, (4) Dalton



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16. Which of the following particles is negatively charged? (1) electron (2) proton (3) neutron (4) cation

17. Whose model of the atom could be represented by the diagram to the right?

- (1) Dalton
(2) Thomson
(3) Rutherford
(4) Bohr



18. Evidence that electrons exist in distinct energy levels outside the nucleus is provided by (1) cathode rays, (2) spectral lines, (3) atomic masses, (4) radioactivity.

19. When excited electrons return to the ground state, they lose excess energy in the form of (1) light, (2) gamma rays, (3) nuclear radiation, (4) sound.

20. Which of the following particles is negatively charged? (1) electron (2) proton (3) neutron (4) cation

21. The modern model of the atom shows that electrons are (1) orbiting the nucleus in fixed paths, (2) found in regions called orbitals, (3) combined with neutrons in the nucleus, (4) located in a solid sphere covering the nucleus

22. The characteristic bright-line spectrum of an element is produced when electrons (1) fall back to lower energy levels, (2) are gained by a neutral atom, (3) are emitted by the nucleus as beta particles, (4) move to higher energy levels

23. What is the maximum number of orbitals in the second principal energy level? (1) 1 (2) 2 (3) 3 (4) 4

24. The sublevel of lowest energy is (1) 2s (2) 3s (3) 2p (4) 3d

25. What is the number of orbitals in a 4d sublevel? (1) 1 (2) 5 (3) 3 (4) 7

26. What is the maximum number of orbitals in a d sublevel? (1) 1 (2) 5 (3) 3 (4) 7

27. A completely filled principal energy level contains 32 electrons. The principal quantum number (n) of this level is (1) 5 (2) 2 (3) 3 (4) 4

28. What is the maximum number of electrons in the third principal energy level? (1) 6 (2) 2 (3) 10 (4) 18

29. In the third principal energy level, the sublevel of highest energy is (1) s (2) p (3) f (4) d

30. A neutral atom always has an equal number of (1) neutrons and electrons, (2) neutrons and protons, (3) protons and electrons, (4) protons, electrons, and neutrons.

31. A new element is discovered with a full 9th principal energy level. How many electrons are in the 9th energy level? (1) 9 (2) 81 (3) 162 (4) 32

32. Using a modified cathode ray tube, Thomson showed that cathode rays respond to a magnetic field by bending, and they respond to electricity by bending away from the negative electrode. Based on these results, Thomson concluded that cathode rays were (1) light energy, (2) negatively charged particles, (3) positively charged particles, (4) indivisible.

Answer questions 33 - 36 by referring to the two experiments described below:

Experiment 1

30 g of carbon are burned in the open air where there is plenty of oxygen. 110 g of a carbon oxide forms.

Experiment 2

30 g of carbon are burned in a closed container under conditions of low oxygen. 70 g of a carbon oxide forms.

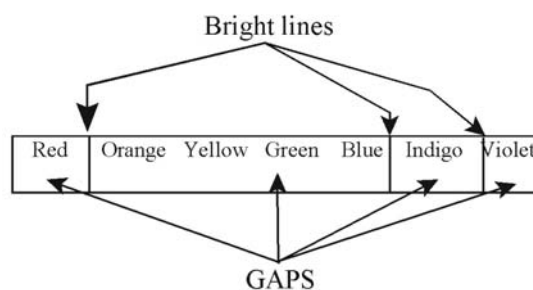
33. How much oxygen does this mean the carbon combined with in *Experiment 1*? (1) 30 g (2) 80 g (3) 110 g (4) 140 g

34. How much oxygen does this mean the carbon combined with in *Experiment 2*? (1) 30 g (2) 70 g (3) 100 g (4) 40 g

35. What is the ratio of the masses of the oxygen combined with carbon in *Experiment 1* and *Experiment 2*? (1) 1:1 (2) 1:1.5 (3) 2:1 (4) 4:1

36. How did Dalton explain results like these? (1) Atoms combine in whole number ratios to form compounds. (2) There are four indivisible elements. (3) Oxygen atoms have two different masses. (4) The properties of elements change when they combine to form compounds.

Answer questions 37 - 40 by referring to the drawing below showing the line spectrum of hydrogen.



37. According to Bohr, what causes the bright lines? (1) Ground state electrons jump up to the excited state. (2) Excited electrons fall back to the ground state. (3) Ground state electrons stay in fixed pathways. (4) Excited electrons emit a full spectrum.

38. What causes the gaps between the bright lines? (1) Ground state electrons have lower energy than excited electrons. (2) Excited electrons are further from the nucleus than ground state electrons. (3) The energy of the electrons is quantized. (4) The energy of the electrons is continuous.

39. Describe the model Bohr used to explain the spectrum of hydrogen. (1) Electrons move in fixed circular pathways. (2) Electrons are found in orbitals. (3) Electrons are evenly distributed throughout a cloudlike positive charge. (4) Electrons are held in fixed positions in an indivisible atom.

40. Why isn't it the Bohr model the accepted atomic model? (1) The Bohr model doesn't explain the spectrum of hydrogen. (2) The Bohr model explains ONLY the spectrum of hydrogen. (3) The Bohr model only works with excited electrons. (4) According to the Bohr model, the energy of the electron is quantized.

