

1. Which statement about electrons is not true?

- (A) Electrons have a negative electrical charge.
- (B) Electrons prevent two atoms from touching.
- (C) For every electron around a nucleus, there is a proton in the nucleus.
- (D) Electron attraction to the nucleus makes it difficult to remove electrons from an atom.**

**Hint:** Electrons are extremely lightweight negatively charged particles (over a thousand times lighter than a proton). Being negatively charged, electrons repel each other with so much strength that atoms approaching each other don't ever touch each other.

The only reason negative electrons stay near each other around a nucleus is that there is usually one positive proton in the nucleus for every electron revolving around the nucleus. The negatively charged electron is attracted to a positively charged proton.

2. Van der Graaf generators \_\_\_\_\_.

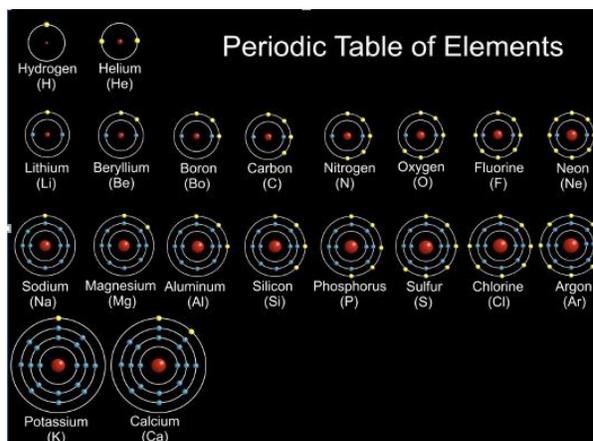
- (A) produce electrons from neutrons
- (B) strip electrons off atoms**
- (C) generate protons from the nucleus
- (D) transfer protons from the atomic nuclei to the dome up top

**Hint:** Van der Graaf generators are, in a sense, vertical treadmills. At the bottom of the treadmill, the moving belt strips electrons off atoms and delivers them to the dome up top. The electrons delivered to the dome are free to move onto your body when you touch the dome.

3. The periodic table is made up of over 100 different elements. Each atom of an element has a nucleus and one or more electrons orbiting around it. The simplest atom is \_\_\_\_\_.

- (A) Hydrogen**
- (B) Helium
- (C) Lithium
- (D) Beryllium

**Hint:** The simplest atom has a single proton in its nucleus and a single electron rotating around the nucleus. That atom is in the upper left corner of the periodic table.



4. Each of the following statements about protons is true, except:

- (A) Protons are found in the nucleus.
- (B) Protons have a positive electrical charge.
- (C) Protons are slightly larger than electrons.**
- (D) Protons repel each other until they get very close to each other.

**Hint:** Protons are positively charged particles, found only in the nucleus, and weighing almost 2000 times more than an electron. A proton's positive charge would normally make two protons repel each other, but the strong force in a nucleus keeps two protons almost touching each other.

5. The most important feature that distinguishes one element from another is \_\_\_\_\_.

- (A) the number of electrons orbiting the nucleus
- (B) the number of protons in the nucleus**
- (C) the number of rings around the nucleus
- (D) the number of neutrons in the nucleus

**Hint:** Removing or adding electrons to an atom makes the atom into an ion.

Removing or adding a proton makes the atom into an entirely new element.

Removing or adding a neutron changes the weight of the atom, but not its chemistry. More or fewer neutrons only make new isotopes of an element.

6. Each of the following statements about neutrons is true, except:

- (A) Neutrons are equal to a proton and an electron.
- (B) Neutrons have no electrical charge.
- (C) Neutrons have a strong force.
- (D) Neutrons prevent electrons from being pulled into the nucleus.**

**Hint:** Neutrons are formed when a proton combines with an electron, resulting in no net electrical charge. Like protons, neutrons have a strong force to help keep protons close together.

7. Which statement about ions is untrue?

- (A) An atom with more electrons than protons is an ion.
- (B) An atom with more protons than electrons is an ion.
- (C) An ion has no overall electrical charge.**
- (D) A neutral atom can be made into either a positive ion or a negative ion.

**Hint:** Ions indicate a mismatch in the number of protons and electrons, either more electrons than protons, or more protons than electrons. In either case, the positive and negative electrical charges are imbalanced, and the atom is now an ion with either a positive or a negative overall electrical charge.

8. The reasons you get shocked when touching a metal doorknob after walking across a carpet include all but the following:

**(A) Metals readily release their electrons from the doorknob.**

- (B) Electrons are rubbed off the carpet.
- (C) Electrons repel each other.
- (D) Electrons can be removed from the nucleus they're orbiting.

**Hint:** Rubbing your feet across a carpet wipes electrons off the atoms in the carpet onto your feet. The extra electrons on your body readily flow from your finger onto any metal, because metals allow electrons to rapidly flow through them.

9. The reason things never actually touch each other is that \_\_\_\_\_.

**(A) the electrons around each atom repel every other atom**

- (B) nuclear charges repel each other
- (C) molecular configuration blocks actual contact between atoms
- (D) at molecular distances, the anti-gravitational strong force becomes active

**Hint:** If the two objects have the same mass, their electrical forces are much stronger than their gravitational forces. Electrons revolving around an atom provide enough repelling force to prevent atoms from touching each other.

10. Protons are able to remain close together in the nucleus because \_\_\_\_\_.

- (A) electrical repulsion drops off rapidly at extremely close distances
- (B) the protons pair up and spin in opposite directions
- (C) their mutual repulsion is offset by the electrons orbiting the nucleus
- (D) at extremely close distances the strong force becomes active**

**Hint:** The positive charge on protons causes them to repel each other with great force as they near each other -- until they get close enough for the strong force to take over. The strong force, which attracts protons and neutrons to each other when they get extremely close to each other, is stronger than the electrical repulsive force between protons.

11. Which statement about neutrons is untrue?

- (A) Neutrons exert a strong force.
- (B) Neutrons nudge protons apart.
- (C) Neutrons have both a negative and positive electrical charge.**
- (D) Neutrons weigh almost the same as a proton.

**Hint:** Neutrons are made from a proton and electron, but since their electrical charges cancel each other out, a neutron has no net electrical charge. Electrons weigh so little that a neutron weighs almost exactly what a proton weighs.

12. The inert elements \_\_\_\_\_.

- (A) may bond with each other but not with other elements
- (B) include hydrogen, helium, neon, and argon
- (C) all have filled outer rings**
- (D) form gases as paired atoms

**Hint:** Inert elements have filled outer shells, meaning two electrons in Ring 1 for helium, eight electrons in Ring 2 for neon, and eight electrons in Ring 3 for argon. Because the inert elements have filled outer rings, they do not need to bond to other atoms in order to fill up their outer ring. They therefore remain as single atoms while floating about as gases.

13. Which statement is untrue?

- (A) Atoms bond to shed themselves of energy.
- (B) Atoms bond by manipulating their electrons.
- (C) The bond formed when two atoms bond is their intermolecular bond.**
- (D) Knowing how two atoms bond predicts the properties of the molecule.

**Hint:** Atoms will do most anything to fill up their outer rings, because doing so allows them to shed extra energy. Forming an intramolecular bond with another atom allows atoms to fill up their outer rings. Atoms use one of four ways to bond to other atoms, and each method of bonding produces its own set of properties in the resulting molecule.

14. Which of the following does the Law of Entropy predict?

- (A) Someday every place in the universe will be the same temperature.**
- (B) Atoms will bond if they can gain energy.
- (C) If necessary, to conform with the Law of Entropy, energy can and will be destroyed.
- (D) Someday all the energy in the universe will be completely used up.

**Hint:** Since energy cannot be destroyed, energy will never be used up, and it will continue to flow, according to the Law of Entropy, anywhere with lower energy. Eventually, there will be no place for energy to flow to, because everywhere will be at the same energy level.

15. In going from a neutral lithium atom to a positively charged lithium ion, a lithium atom \_\_\_\_\_.

- (A) gains an electron
- (B) loses an electron**
- (C) gains a proton
- (D) loses a proton

**Hint:** Gaining or losing a proton changes the element. For lithium to remain lithium, it can only gain or lose an electron and become a lithium ion. Losing an electron means it will have more protons than electrons, making its net charge positive.

16. Different isotopes of an element have different \_\_\_\_\_.

- (A) nuclear charge
- (B) numbers of electrons
- (C) numbers of protons
- (D) numbers of neutrons**

**Hint:** An isotope is an atom that has more or fewer neutrons than other isotopes of that element.

Because all isotopes of an element have the same number of protons, they behave chemically pretty much the same.

Changing the number of electrons makes a neutral atom an ion.

Changing the number of neutrons makes an atom a different isotope.

Changing the number of protons makes an atom a different element altogether.