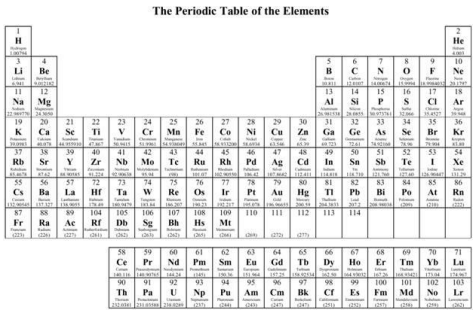
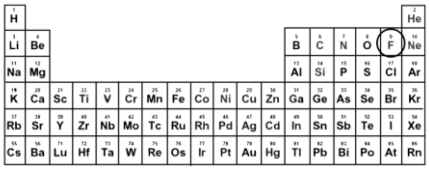
1. How many electrons would each fluorine atom have to share when two fluorine atoms bond to form a molecule of fluorine gas -- both with a completely filled Ring 2?



(A) 1
(B) 2
(C) 3
(D) 4

Hint: Atoms want to fill up their outer ring, because doing so allows atoms to shed excess energy. Fluorine needs only one electron to fill up its outer ring, so each fluorine atom only needs to share one electron with another fluorine atom.



2. How many electrons would two oxygen atoms have to share to form a molecule of oxygen that fills up both of oxygen's Ring 2?

(A) 1
(B) 2
(C) 8
(D) 10

Hint: Oxygen needs two electrons to fill up its outer ring, so each oxygen atom would share two electrons with another oxygen atom.

3. How many electrons would two nitrogen atoms have to share to form a molecule of nitrogen that fills up both of nitrogen's Ring 2?

(A) 1
(B) 2
(C) 3
(D) 5

Hint: Nitrogen needs three electrons to fill up its outer ring, so each nitrogen atom needs to share three electrons with another nitrogen atom.

4. The reason two identical atoms stay together when sharing electrons equally is that they _____.

(A) form a single cloud of electrons around both atoms
(B) they form a wall of electrons between them
(C) each atom's electrons begin circling the other atom
(D) the electrons share each other's repulsion

Hint: In an equal sharing intramolecular bond, the electrons are shared equally by bunching up midway between the two atoms. Each positively charged nucleus is attracted to the wall of electrons between the two atoms. The wall of electrons keeps the nuclei pulling toward each other to form a covalent bond.

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5. Which molecule has the strongest equal sharing covalent bond?

(A) nitrogen
(B) oxygen
(C) fluorine

Hint: The more electrons shared by two identical atoms, the more attracted the atoms are to the wall of electrons between them. Nitrogen shares three electrons, oxygen - two electrons, and fluorine - one, so two nitrogen atoms see a more electrically negative wall of electrons than either oxygen or fluorine.

6. Covalent bonding causes two atoms to stick together because _____.

(A) both nuclei are attracted to each other
(B) both atoms become ionic
(C) the shared electrons are attracted to each other
(D) both nuclei are attracted to the shared electrons

Hint: A covalent bond involves equal sharing of electrons between two atoms. Even if the two atoms are not identical, by being closer to the shared electrons, the smaller nucleus is still able to exert a force equal to the force exerted by the larger nucleus.

7. Which statement is untrue? Small covalent molecules _____.

(A) have no polarity
(B) form gases at room temperature
(C) always form when two identical atoms bond together
(D) are generally asymmetric

Hint: A covalent molecule is made up of equal sharing atoms. Sharing equally means neither side of the molecule is more positive or more negative than the other side, because the electrons are shared equally.

The only way two identical molecules could share electrons is equally.

With no polarity to a covalent molecule, there is little attraction between any two molecules and the molecules commonly form gases.

8. Carbon and hydrogen form a covalent bond with each other because _____.

(A) hydrogen with a single electron is willing to give carbon its single electron
(B) their electronegativity difference is greater than 2.0
(C) hydrogen's nucleus exerts a strong pull on its single electron
(D) carbon's three other valence electrons repel the fourth valence electron toward the hydrogen atom

Hint: Even though carbon and hydrogen are entirely different atoms, each atom pulls on its valence electron nearly equally.

Even though hydrogen has only one proton, it is still able to exert a strong pull on its single electron because its electron is so close to the proton in the nucleus.

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9. Which statement is untrue? Methane is a gas at room temperature, in part, because _____.

(A) methane molecules repel each other
(B) methane molecules are symmetric
(C) methane molecules have four covalent bonds
(D) methane molecules are small

Hint: In methane, carbon shares its four valence electrons equally with four hydrogen atoms.

Because each hydrogen atom is equidistant from every other hydrogen atom, there is no overall polarity to the methane molecule.

That means two methane molecules neither attract nor repel each other (except for the brief instant when all the electrons happen to find themselves more on one side of the methane molecule than the other).

10. Which statement is untrue? The more carbon atoms a long-chain hydrocarbon has, the more likely it is to _____.

(A) stick to other identical molecules
(B) have a lower boiling point
(C) form a liquid at room temperature
(D) form London dispersion forces

Hint: Even though carbon and hydrogen form an equal sharing covalent bond, carbon-hydrogen molecules can still be attracted to each other through London dispersion forces, when electrons in motion happen to overload one side of a molecule and make the molecule momentarily polar.

The more carbon-hydrogen bonds a molecule has, the more likely this is to happen. Stickier molecules have a higher boiling point, meaning it takes more energy to separate the molecules in their liquid state and allow them to float away as a gas.

11. Which statement is untrue? London dispersion forces _____.

(A) are brief and unpredictable
(B) occur between nonpolar molecules
(C) are due to shifts of electrons
(D) cause electrons to disperse evenly around the nucleus

Hint: London dispersion forces occur when moving electrons happen to overload one side of a molecule for a split second and make the molecule momentarily polar. If the same thing happens to two adjacent molecules, they will be attracted to each other for a brief moment.

Alternatively, the momentarily polar molecule can repel the electrons on a neighboring molecule to the opposite side of that molecule. Now both molecules are polar and experience a London dispersion force.

12. The best way to turn a gas into a liquid is to _____.

(A) increase the pressure and temperature
(B) lower the pressure and increase the temperature
(C) increase the pressure and lower the temperature
(D) lower the pressure and temperature

Hint: Anything that gets gas molecules closer together increases the likelihood that they will be attracted to each other and form into a liquid.

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Two ways to get gas molecules closer together is squeezing them together with increased pressure, and by cooling the gas molecules, which removes the energy they need to bounce away from each other.

The reason gas molecules become attracted to each other is either because they have some polarity or, if they're not polar, because of brief London dispersion forces occurring between the gas molecules.

13. Which is the most effective way to reduce London dispersion forces between long-chain hydrocarbons?

(A) lower the temperature
(B) reduce the number of carbon atoms
(C) remove any double bonds
(D) increase the pressure

Hint: London dispersion forces occur between nonpolar molecules such as long-chain hydrocarbons. The closer together the chains are, and the longer the chains are, the stronger the London dispersion forces.

Double bonds are very strong bonds because they consist of twice as many electrons between two atoms. However, with the electrons locked between two atoms, there are fewer electrons to roam about and overload one side of a molecule to form a London dispersion force.

Lowering the temperature and increasing the pressure forces molecule together and allow London dispersion forces to pull the molecules together.

14. Saturated hydrocarbons _____.

(A) have periodic double bonds which makes stacking of the hydrocarbons more difficult
(B) have no double bonds which makes stacking of the hydrocarbons easier
(C) have no double bonds which makes stacking of the hydrocarbons more difficult
(D) have periodic double bonds which makes stacking of the hydrocarbons easier

Hint: "Saturated" refers to being saturated with the maximal number of hydrogen atoms possible. To do this requires no double bonds between carbon atoms so that each carbon atom can bond to the maximal number of hydrogen atoms with single bonds.

Since double bonds kink a hydrocarbon, the absence of double bonds makes it easier to stack flat hydrocarbons atop one another.

15. Geckos and spiders are able to walk on walls and ceilings by the following adaptations, except:

(A) increasing the pressure exerted by their feet on the walking surface
(B) increasing the number of molecules in their feet that come in contact with the walking surface
(C) relying on London dispersion forces
(D) increasing the number of hairs on their feet

Hint: Geckos are able to walk upside down because there have so many molecules in their feet exerting London dispersion forces on molecules in the ceiling.

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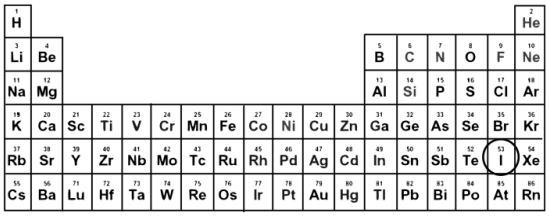
The reason Geckos have so many molecules in their feet is that they have enormous numbers of folds in the skin of their feet. These folds are able to bring a huge number of molecules into contact with molecules in the ceiling.

16. Iodine atoms form covalent bonds with each other, but unlike other small covalent molecules, iodine molecules form a solid at room temperature, because, in part, of their _____.

(A) small electron cloud
(B) low molecular weight
(C) high kinetic energy
(D) strong London dispersion forces

Hint: Iodine atoms have five electron rings. With so many electrons, the likelihood of electron overload in an iodine molecule is quite high. Unless these large iodine atoms have enough kinetic energy to bounce away from each other, their London dispersion forces tend to keep them stuck together.



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