

1. All processes/conversions proceed in the direction of the lowest energy state.
2. No. It will take place only when the route from the starting state to the final state is accessible, e.g. it does not pass through a very high energy intermediate state.
3. Increasing the temperature increases the average energy of the starting materials. A sufficient increase in this average energy could, given the distribution of energies of the starting materials, give some of them sufficient energy to overcome the activation energy barrier.
4. In favor of use—
 - a. The unity principle states that organisms are fundamentally the same with regard to their molecules and processes. Thus it is reasonable to assume that a drug that performs a certain function in monkeys would perform the same function in humans.
 - b. Individuals with serious, terminal diseases might choose to take unproved drugs since they have little to lose and much to gain

Against use—

- a. The unity principle also states that the differences we see between organisms are due to the differences in their molecules and processes. Thus it cannot be definitively stated that what is effective treatment in monkeys is effective treatment in people.
- b. Without thorough human testing for safety, there can be no assurance that there will not be serious side effects associated with taking the drugs.

5. Hydrogen atom has one electron. Lower energy would be achieved with complete set of two electrons. If another hydrogen atom comes close and the two share their electron, each will have two electrons nearby, and both will be at lower energy. The two atoms stay near each other. To move apart would increase their energy, since again each would have only one electron. They share electrons in this covalent bond.

6. If the hydrogen atom completely loses an electron, then it loses a negative charge and is left with a positive charge. It is known as a hydrogen ion. [This is similar to sodium gaining an electron to become sodium ion.]

7. Covalent bond: Electrons shared by the two atoms involved. Each “counts” the shared electrons as its own. Each is at a lower energy when its number of electrons reaches the level of 2 or 10 or 18 etc. Thus it is at a lower energy when it is close enough to the other atom to share the electron. Thus the two atoms will stay near each other and appear to be “bonded” to each other.

Ionic (electrostatic) bond. One atom has completely given up or fully gained one or more electrons to reach the 2, 10, 18 etc level. If it has given up negatively charged electrons, it now has a positive charge and the reverse. Resulting ions that are positive will be strongly attracted to negative ions and will stick together and appear to be “bonded” to each other.

Hydrogen bonds. If electrons in a covalent bond are not shared equally, one will have a partial positive and the other a partial negative charge. The partially positively charged atom is attracted to a partially negatively charged atom in another molecule (and the reverse) and appears to be “bonded” to it. In biological systems, hydrogen atoms can have a partially positive charge because bonding to an oxygen or nitrogen which

becomes partially negative. That hydrogen will thus be attracted to the partially negative oxygen or nitrogen of another molecule forming a hydrogen bonded between them.

8. The high heat of fusion of water means that a large amount of heat is released when water freezes to ice while maintaining the same temperature. As a result, there is less of a temperature drop than would otherwise occur when there is less heat in the environment.

9. Isotopes have the same number of electrons even though they have different number of neutrons. Since chemical reactions and chemical bonding depend only on the number of electrons, isotopes behave the same, except for the disintegration of the nucleus, which changes the nature of the atom completely.

10. Water molecules are polar with partial + charge on H, partial - charge on O. As a result they associate, through hydrogen bonds. Turning a liquid into a gas involves separation of individual molecules from one another. Water, since it has H bonds, requires more energy to separate molecules. That energy need is met by raising the temperature. Thus, water stays liquid until higher temperatures reached (e.g., 100°C) than other, non H-bonded molecules.

11a. Product of reaction is at lower energy, but the only path to that product goes through high energy intermediate (transition state). ATP is stable because very few, if any, of the molecules in a population of ATP molecules have high enough energy to get over the activation energy “bump”.

b. Heat it. Adds energy. Average energy of molecules increased, thus more have enough to get over activation energy hump.