

1. What are the electrical charges of the cathode and anode in a battery versus electrolysis?

(A) The cathode is the positive terminal, and the anode the negative terminal in both a battery and electrolysis.

(B) The cathode is the negative terminal, and the anode the positive terminal in both a battery and electrolysis.

**(C) The cathode is the positive terminal in a battery and the anode the negative terminal, but in electrolysis, the cathode is the negative electrode and the anode the positive electrode.**

(D) The cathode is the negative terminal in a battery and the anode the positive terminal, but in electrolysis, the cathode is the positive electrode and the anode the negative electrode.

The correct answer is C. The cathode is the terminal where positive ions are reduced by electrons flowing to the cathode through a wire. In electrolysis, electrons arriving at the cathode reduce positive ions in solution that then accumulate on the cathode as reduced neutral atoms. In electrolysis, the cathode is negative and the anode positive. The anode is positive because electrons in the anode are being removed and sent up the wire to the cathode, leaving behind the oxidized atoms in the anode that now, being positive ions, enter the solution around the anode.

In a battery, the cathode is positive and the anode negative, opposite of electrolysis, because the electrons entering the battery through a wire attached to the positive electrode are now reducing positive ions at the cathode. Electrodes are abundant at the negative terminal of a battery, but they are not reducing any positive ions there. Reduction of positive ions into neutral atoms defines a cathode.

2. In an electrolysis apparatus, there are three columns. What is the purpose of the central column?

(A) The central column ensures that the right and left columns have the exact same solution.

(B) The central column allows gas to accumulate in the right and left columns.

(C) The central column is where the gases from the right and left columns mix.

**(D) The first two answers are correct.**

The correct answer is D. A single solution is poured into the central column and that fluid fills up the right and left columns, pushing the air out of those columns through the open valve at the top of the right and left columns. During electrolysis, gas accumulates in the right and left columns, and pushes the solution in each column downward back into the central column.

3. How do you distinguish hydrogen gas from oxygen gas?

- (A) Hydrogen gas expands faster than oxygen gas.
- (B) Hydrogen gas produces a blue flame, oxygen a bright yellow flame.
- (C) Hydrogen gas is easier to ignite than oxygen gas.
- (D) Hydrogen gas pops while oxygen gas brightens a flame.**

The correct answer is D. Hydrogen gas explodes when it comes into contact with fire, while oxygen gas causes the fire to brighten, especially when the flame is about to go out.

4. How many electrons does an oxygen atom need to fill up its Ring 2?

- (A) 1 electron
- (B) 2 electrons**
- (C) 3 electrons
- (D) 4 electrons

The correct answer is B. Oxygen has eight electrons, two in Ring 1, and six in Ring 2. Oxygen needs two more to fill up its Ring 2.

5. Oxygen's nucleus is eight times larger than hydrogen's nucleus, yet when oxygen bonds with two hydrogen atoms to fill up its Ring 2, each hydrogen atom shares its single electron with oxygen instead of giving it to oxygen. How are the hydrogen atoms able to prevent oxygen from taking each of their electrons?

- (A) Hydrogen's nucleus is closer to the shared electrons than oxygen's nucleus is.
- (B) Hydrogen's nucleus has no electrons blocking its view of the shared electrons.

**(C) The first two answers are correct.**

(D) Oxygen prefers to share one of its own electrons with hydrogen's electron because it allows that end of the water molecule to have a positive electrical charge.

The correct answer is C. Answer D is incorrect because the hydrogen end of a water molecule would still be positive even if each hydrogen had given its electron to oxygen. Sharing electrons didn't allow the hydrogen end of the water molecule to become electrically positive. The hydrogen end of a water molecule becomes electrically positive because that end had hydrogen nuclei and the other end didn't.

6. Factors that make a water molecule more polar than you might expect include the following, except \_\_\_\_\_.

- (A) each hydrogen nucleus is electrically positive
- (B) electrons circle the nucleus in pairs
- (C) each pair of electrons circling the nucleus repels every other pair
- (D) an unshared pair of electrons exerts more repulsion than a shared pair of electrons**

The correct answer is A. The mere fact that hydrogen nuclei are positive simply means that end of the water molecule will be positive, not more positive than you'd expect. What makes the hydrogen end of the water molecule more positive than you'd expect is that the two pairs of shared electrons are squeezed together because electrons travel in pairs, each pair repels every other pair, and the two unshared pairs of electrons on the oxygen side of the water molecule exert more repulsion than the shared pairs on the hydrogen end of the water molecule.

7. How many degrees are there in a complete circle and in a right angle?

- (A) Full circle:  $300^\circ$ , Right angle:  $180^\circ$
- (B) Full circle:  $300^\circ$ , Right angle:  $90^\circ$
- (C) Full circle:  $360^\circ$ , Right angle:  $180^\circ$
- (D) Full circle:  $360^\circ$ , Right angle:  $90^\circ$**

