1. Which statement is untrue?

(A) London dispersion forces develop between polar covalent molecules.
(B) London dispersion forces turn gases into liquids.
(C) London dispersion forces are most effective at turning gases into liquids when the gases are cool and under high pressure.
(D) London dispersion forces last a very short period of time.

The correct answer is A. London dispersion forces attract covalent molecules together, while hydrogen bonding attracts polar covalent molecules together. London dispersion forces are very brief and rather weak, so the covalent molecules have to be fairly close and slow moving for two covalent molecules to be pulled together. Cool gases under pressure force gas molecules close together. If enough London dispersion forces kick in, gases can be turned into liquids.

2. Which statement is true?

(A) A carbon dioxide molecule with a negative charge on each oxygen side is polar.
(B) A carbon dioxide molecule with a negative charge on each oxygen side is nonpolar.
(C) Identical nonpolar molecules will not stick to each other unless you lower both the temperature and pressure.
(D) Identical nonpolar molecules will not stick to each other unless you raise the temperature and pressure.

The correct answer is B. Carbon dioxide does have a negative charge on each oxygen end of the molecule, but because the molecule is symmetric, carbon dioxide is nonpolar. The way to get nonpolar molecules like carbon dioxide to begin sticking to each other is to increase its pressure and lower the heat and allow London dispersion forces to pull two atoms together for a brief moment.

3. Which statement about nonpolar molecules is untrue?

(A) Nonpolar molecules are not attracted to other nonpolar molecules.
(B) Nonpolar molecules are not attracted to polar molecules.
(C) The molecules in a sample of nonpolar molecules are more mobile than the molecules in a sample of polar molecules.
(D) Small nonpolar molecules form liquids at room temperature and normal atmospheric pressure.

The correct answer is D. Nonpolar molecules have no reason to be attracted to another molecule, whether they're polar or nonpolar. Even a nonpolar molecule like carbon dioxide, which has a negative charge on each side, is not attracted to a polar molecule, because all the polar molecule sees is the entire nonpolar carbon dioxide molecule, not the negative charges on each side of the carbon dioxide molecule. In order to get nonpolar molecules to stick to each other with London dispersion forces, the nonpolar molecules have to be brought together by removing heat energy and/or pushing the nonpolar molecules together with a higher gas pressure.

4. Which arrangement of molecules is most polar to least polar?

(A) water molecule, sodium chloride molecule, oxygen molecule
(B) sodium chloride molecule, water molecule, oxygen molecule
(C) water molecule, oxygen molecule, sodium chloride molecule
(D) sodium chloride molecule, oxygen molecule, water molecule

The correct answer is B. Ionic bonds produce the most polar molecules, then polar covalent, and last covalent bonds.

5. Why do bubbles suddenly start forming when the temperature of water reaches the boiling point?

(A) It takes 100 Celsius degrees to provide water with enough energy for bubbles of air to form.
(B) It takes 100 Celsius degrees to provide water with enough energy to finally allow molecules to evaporate.
(C) It takes 100 Celsius degrees to provide water with enough energy for water molecules to break their intramolecular bonds.
(D) It takes 100 Celsius degrees to provide water with enough energy for bubbles of steam to form.

The correct answer is D. The bubbles in boiling water are filled with steam, i.e., water molecules at or above the boiling point.

6. Why does it take 100 degrees Celsius for bubbles of steam to start forming in water?

(A) In order for steam bubbles to form in water, the pressure inside the bubbles has to equal atmospheric pressure pressing down on the water. It takes 100 degrees Celsius to generate that high a pressure inside the bubbles.
(B) In order for steam bubbles to form in water, water molecules have to have enough energy to break their intermolecular bonds and evaporate as steam.

(C) In order for steam bubbles to form in water, water molecules have to have enough energy to evaporate steam from the surface of the water and neutralize air pressure pressing down on the water.
(D) The first two answers are true.

The correct answer is D. The primary reason bubbles start forming is that they finally have enough energy to form bubbles equal in pressure to the air pressing down on the water. At the boiling point, water also has enough heat energy to readily break the intermolecular bonds between water molecules and allow water molecules to evaporate as gaseous stem.

7. If it takes 100 degrees Celsius temperature to break hydrogen bonds between water molecules and allow water molecules to evaporate into the air, how come water molecules are able to evaporate into the air at temperatures below the boiling point?

(A) Because some water molecules don't need 100 degree Celsius heat to break their intermolecular bonds in order to evaporate.
(B) Because wind energy is able to contribute to water's heat energy by allowing air molecules to bump into water molecules and bump them into the air.
(C) Because not all water molecules have the same amount of energy. Some water molecules in a sample of water below the boiling already have 100 degrees of energy and can evaporate into the air.
(D) Because some water molecules experience the force of repulsion between water molecules.

The correct answer is C. In any sample of water, there is a distribution of energy among the water molecules with some have high energy and some low energy. Those with high energy evaporate first and only when more heat is added do the other water molecules have enough energy to evaporate.

8. Why is steam invisible?

(A) Steam is a gas and all gases are invisible because gas molecules are so far apart.
(B) Like water molecules in a liquid state, water molecules in a gaseous state don't absorb light very well.
(C) Both are true but the first answer is the main reason.
(D) Both are true but the second answer is the main reason.

The correct answer is A. All gases are invisible primarily because the molecules are so far apart that light has no trouble passing through the gas.

9 What is water vapor?

(A) Water vapor is a visible cloud of water molecules below the boiling point of water.
(B) Water vapor is an invisible gas of water molecules below the boiling point of water.
(C) Water vapor is a collection of tiny water droplets in the air.
(D) Water vapor is a mist or cloud of water molecules in the air.

The correct answer is B. Water vapor is a gas and therefore invisible. The water molecules in water vapor are below the boiling point of water. Clouds, mist, and fog are all synonyms for collections of tiny water droplets in the air.

10. What is air pressure?

(A) Air pressure is the total weight of the air pressing down on the earth.
(B) Air pressure is the total force of the air pressing on the earth.
(C) Air pressure is the weight of the air pressing down on a square meter or square foot of the earth.
(D) Air pressure is the total mass of the air surrounding the earth.

The correct answer is C. Pressure is force per unit of area. The force is the force of gravity, so the force is the weight of air. Pressure is the weight of air pressing down on a unit of area. The units for pressure are typically pounds per square inch, or kilograms per square centimeter. Air pressure at sea level is 14.7 pounds per square inch. In the metric system, air pressure is the weight of 1 kilogram of air per square centimeter, which is 1 Newton per square centimeter. 1 Newton per square centimeter is 1 Pascal.

11. The volume of a gas depends on _____.

(A) The weight of each gas molecule
(B) The size of each gas molecule
(C) The mass of each gas molecule
(D) The number of gas molecules

The correct answer is D. Because gas molecules are so far apart, the only thing that determines its volume is the number of gas molecules, not the size, weight, or mass of each gas molecule.

12. In the periodic chart, each element has an atomic weight. What are the units for atomic weight?

(A) grams
(B) milligrams
(C) picograms
(D) atomic mass units

The correct answer is D. The units of weight for each atom in the periodic chart are given in atomic mass units.

13. How many atoms would it take to accumulate enough atoms for the collection to weigh the atom's atomic weight in grams?

(A) 6.02×10^{21} atoms
(B) 6.02×10^{22} atoms
(C) 6.02×10^{23} atoms
(D) 6.02×10^{24} atoms

The correct answer is C. It would take 6.02×10^{23} atoms for the pile of atoms to weigh the atom's atomic weight in grams. 6.02×10^{23} is 1 mole.

14. What are two ways to express the energy of a gas?

(A) pressure times volume, and number of gas molecules times the temperature of the gas
(B) pressure times temperature of the gas, and number of gas molecules times the volume
(C) pressure times number of gas molecules, and volume times the temperature of the gas
(D) pressure times volume, and number of gas molecules times the gas constant

The correct answer is A. The energy of a gas can be measured by its pressure times its volume (PV), or by the number of gas molecules times the temperature of the gas (nT). Since both PV and nT measure the same thing, they equal other, and to make the units match, a gas constant, R, is added. So: PV = nRT, the ideal gas law.