ANSWER KEY. Sample answers are shown. Accept equivalent wording and reasoning.

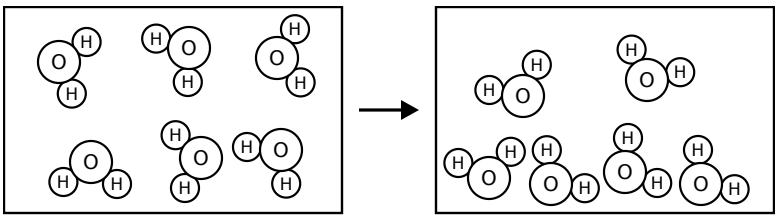
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Physical and Chemical Changes

AP Chemistry | ANSWER KEY

For each change, study the particle diagram and the observations. Then write a claim, evidence, and reasoning. **Claim:** physical or chemical. **Evidence:** what the diagram and data show. **Reasoning:** bonds vs. IMFs.

1.



$H_2O(g)$ $H_2O(l)$

Droplets on a cold glass

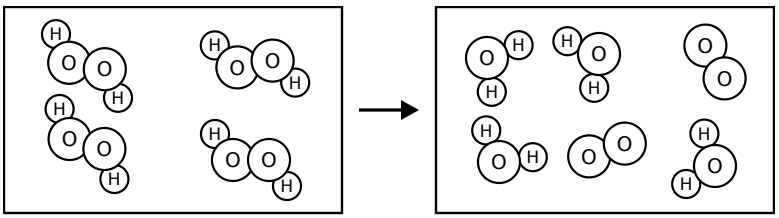
Humid air touches a cold glass of ice water. Droplets form on the outside of the glass. The droplets freeze at 0 °C and boil at 100 °C.

Claim: Physical change.

Evidence: The diagram shows the same six H_2O molecules before and after, each still one O and two H. Only the spacing changed. The droplets freeze at 0 °C and boil at 100 °C, the properties of water, so no new substance formed.

Reasoning: As the vapor cools, the molecules slow down and are pulled together by hydrogen bonds (IMFs) between molecules. No O-H covalent bonds inside the molecules break or form. Only IMFs changed, so this is a physical change (a phase change).

2.



$H_2O_2(l)$ $H_2O(l) + O_2(g)$

Hydrogen peroxide and a catalyst

A pinch of catalyst (not shown) is added to hydrogen peroxide. Bubbles form quickly. The gas makes a glowing splint burst into flame. The liquid left behind boils at 100 °C.

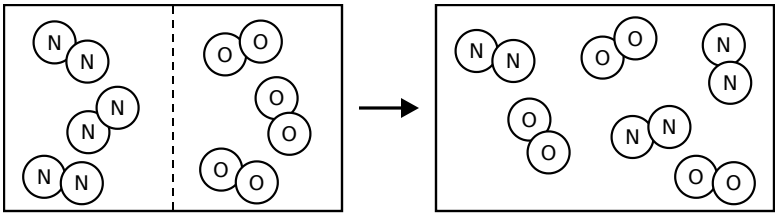
Claim: Chemical change.

Evidence: Four H_2O_2 molecules become four H_2O and two O_2 molecules, which are new particles (8 H and 8 O on each side). The gas relights a glowing splint (O_2), and the liquid boils at 100 °C (water), so new substances formed.

Reasoning: Bonds inside the H_2O_2 molecules (O-O and O-H) break, and new bonds form: O=O in O_2 and O-H in H_2O. Atoms rearranged into new substances: $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$.

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3.



$N_2(g)$ | $O_2(g)$ mixture of gases

Two gases mix

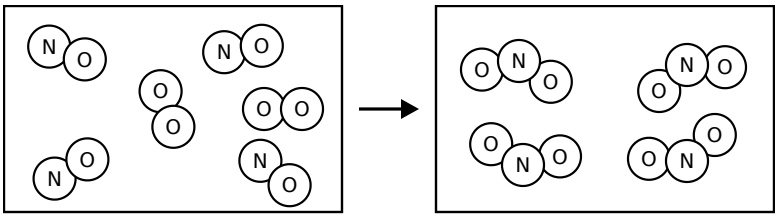
A valve between a flask of N_2 and a flask of O_2 is opened. The gases spread through both flasks. There is no color or temperature change. Cooling the mixture can separate the two gases again.

Claim: Physical change.

Evidence: There are three N_2 and three O_2 molecules before and after; they are only mixed. No color or temperature change, and the gases can be separated by cooling.

Reasoning: Mixing only changes where the molecules are. The N≡N and O=O bonds stay intact and no new bonds form, so no new substance is made. Forming a mixture is a physical change.

4.



$NO(g) + O_2(g)$ $NO_2(g)$

NO meets O_2

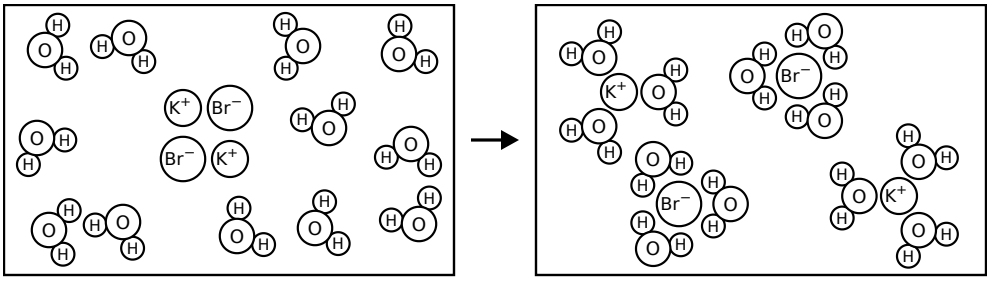
Colorless NO gas is mixed with colorless O_2 gas. The mixture turns reddish brown and warms up. Compare this diagram with problem 3.

Claim: Chemical change.

Evidence: Four NO and two O_2 molecules become four NO_2 molecules, a new substance (4 N and 8 O on each side). The color change and the warming show a new substance and an energy change.

Reasoning: The O=O bonds break and new N-O bonds form, so atoms rearrange into NO_2: $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$. Unlike problem 3, which used the same elements, bonds changed here.

5.



$KBr(s) + H_2O(l)$ $KBr(aq)$

KBr in water

Solid KBr is stirred into water. The solid disappears, and the solution now conducts electricity. The temperature drops slightly. Evaporating the water leaves solid KBr.

Claim: Physical change (sample). Either claim earns credit with matching reasoning.

Evidence: The same K^+ and Br^- ions and the same twelve H_2O molecules appear before and after. Evaporating the water gives back solid KBr, so no new substance formed.

Reasoning: The ions separate and are surrounded by water: the O end of H_2O faces K^+ and the H end faces Br^- (ion-dipole attractions). No O-H bonds in water break, and the ions are unchanged.

Other side: *give one piece of reasoning someone could use for the opposite claim.* **Chemical side: the ionic bonds holding the KBr crystal together break, new ion-dipole interactions form, and a new property (conductivity) and a temperature change appear.**

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