Periodicity: Important Reactions for Oxides of Elements in Period 3 and Other

(Note: Metallic Oxides with Na and Mg behave as bases, and when they react with water form alkaline solutions. Aluminum and Silicon do not react with pure water, but can react with both acids and bases to produce salt and water. And the molecular covalent nonmetals S, P, and Cl produce strong acidic solutions and react with bases.)

Sodium:

$$Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$$

$$Na_2O_{(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(s)} + H_2O_{(l)}$$

Magnesium:

$$MgO_{(s)} + \ H_2O_{(l)} \rightarrow Mg(OH)_{2\,(aq)}$$

$$MgO_{(s)} + HCl \rightarrow MgCl_{2\,(aq)} + \ H_2O_{(l)}$$

Aluminum:

When reacts with base: $Al_2O_{3\,(s)} + 3H_2O_{(l)} + 2OH^-{}_{(aq)} \rightarrow 2Al(OH)_4{}^-{}_{(aq)}$ - This equation can also be written as: $Al_2O_{3\,(s)} + 3H_2O_{(l)} + 2NaOH_{(aq)} \rightarrow 2NaAl(OH)_{4(aq)}$

When reacts with acid: $Al_2O_{3\,(s)} + 3H_2SO_{4\,(aq)} \rightarrow Al_2(SO_4)_{3\,(aq)} + 3H_2O_{(l)}$, the oxide can also react with hydrochloric acid as such:

$$Al_2O_{3\,(s)} + 6HCl_{\,(aq)} \rightarrow 2Al_2Cl_{3\,(aq)} + 3H_2O_{(l)}$$

Silicon:

$$SiO_{2\,(s)} + 2NaOH_{(aq)} \rightarrow Na_2SiO_{3\,(aq)} + \ H_2O_{(l)}$$

(Silicon never reacts with water, it behaves as a weak base as shown above)

Sulfur:

$$SO_{3\,(g)} + H_2O_{(l)} \rightarrow \ H_2SO_{4\,(aq)}$$

$$SO_{2\,(g)} + H_2O_{(l)} \rightarrow \ H_2SO_{3\,(aq)}$$

(No reaction with base shown, but just assume NaOH and derive that products will be Salt and Water)

Phosphorus:

$P_4O_{10\,(s)} + 6H_2O_{(l)} \rightarrow 4H_3PO_{4\,(aq)}$ (Product is hydrogen phosphate; a very strong acid)

(Again, no reactions with bases shown)

Chlorine:

$Cl_2O_{7\,(l)} + H_2O_{(l)} \rightarrow 2HClO_{4\,(aq)}$ (perchloric acid)

Remember that reactions between a halogen and an alkali metal yield halides.

$$2Na_{(s)} + Cl_{2\,(g)} \rightarrow 2NaCl_{2\,(s)}$$

The presence of halide ions in a solution can be determined by adding aqueous silver nitrate where the general form of the equation is:

$$Ag^{+}{}_{(aq)} + X^{-}{}_{(aq)} \rightarrow AgX_{(s)} \;\; where\ x = Cl, Br, or\ I$$

Resulting AgCl will be white, AgBr will be cream colored, AgI will be yellow.

When halogens are used as oxidizing agents they appear in equations like the one below:

$Cl_{2\,(aq)} + 2I^{-}_{(aq)} \rightarrow Cl^{-}_{(aq)} + I^{-}_{2\,(aq)}$

For these type of reactions, the diatomic molecule, in this case chlorine must always have a higher reactivity that the ion. Some IB questions ask for changes in the color of solution for that just know that chlorine is green/yellow, iodine is brownish/reddish, and bromine is colorless (ions of halogens are colorless)

With regards to the reactions of alkali metals with distilled water:

$2Li_{(s)} + 2H_2O_{(l)} \rightarrow 2LiOH_{(aq)} + H_{2\,(g)}$

In this reaction lithium reacts slowly and keeps its shape. The sample of lithium floats.

$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2\,(g)}$

In this reaction sodium reacts so vigorously that the heat produced is sufficient to melt any unreacted metal. This unreacted metal forms into a ball and moves on the water's surface.

$2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2\,(g)}$

In this reaction, the heat produced is sufficient to ignite the hydrogen gas that results and thus produces a lilac/violet colored flame.

Note that all the above reaction is shown with spectator ions. It is important to realize that the base $2XOH_{(aq)}$ can also be written as $2X^{+}_{(aq)} + 2OH^{+}_{(aq)}$. This form is seen in most IB questions. You have to be smart about recognizing spectator ions.