



### Chemistry and World War I

Chemical weapons were first used in World War I. They were primarily used to demoralize, injure, and kill entrenched defenders, against whom the indiscriminate and generally slow-moving or static nature of gas clouds would be most effective. The types of weapons employed ranged from disabling chemicals, such as tear gas, to lethal agents like phosgene, chlorine, and mustard gas. This chemical warfare was a major component of the first global war and first total war of the 20th century. The killing capacity of gas was limited, with only about 90,000 fatalities from a total of some 1.2 million casualties caused by gas attacks. Gas was unlike most other weapons of the period because it was possible to develop effective countermeasures, such as gas masks. In the later stages of the war, as the use of gas increased, its overall effectiveness diminished. The widespread use of these agents of chemical warfare, and wartime advances in the composition of high explosives, gave rise to an occasionally expressed view of World War I as "the chemists' war." -whol.edu

Complete the charts/ questions below using some of the chemicals/ gases used against soldiers in WWI.

Gas #1: <b>Chlorine</b>	
Symbol	
Atomic Number	
Family/ Group Number	
Period	
Electron configuration	
Valence electrons	
Number of protons, neutrons, electrons	
Pure substance or mixture (homogeneous/heterogeneous)	
Metal, non-metal, or metalloid? Some key properties?	
Draw Lewis structure	

Write the following sentence as a balanced chemical equation: When soldiers breathed in chlorine gas ( $\text{Cl}_2$ ) and it mixed with the water vapor in their lungs, it created hydrochloric acid and hypochlorous acid ( $\text{HClO}$ ); however, this reaction is reversible.

What type of chemical reaction is this? (Synthesis, decomposition, etc.)

What is the molar mass of the hypochlorous acid produced by this reaction?

Gas #2: Phosgene (CoCl <sub>2</sub> )		
The two elements in this compound are:	1.	2.
Symbol		
Atomic Number		
Family/ Group Number		
Period		
Electron configuration (Atomic #1-20 only)		
Valence electrons		
Number of protons, neutrons, electrons		
Metal, non-metal, or metalloid? Some key properties?		
Draw Lewis structure, including bonding		

Identify the VESPR/ molecular geometry for this compound.

What is the correct nomenclature (name) for this binary compound?

Write the following sentence as a balanced chemical equation: Phosgene was a particularly deadly gas because when it mixed with water vapor in soldiers' lungs or in the atmosphere, it created hydrochloric acid and carbon dioxide gas, both of which are extremely dangerous.

What type of chemical reaction is this? (Synthesis, decomposition, etc.)

What is the molar mass of phosgene?

It is believed that during the war, the British used approximately 25,000 metric tons of gas. Assuming all of the gas was phosgene, how many moles of phosgene would have been used? Use scientific notation! (1 metric ton = 1000 kg).

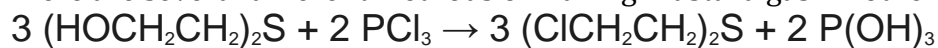
Gas #3: Mustard Gas ((ClCH <sub>2</sub> CH <sub>2</sub> ) <sub>2</sub> S)				
The four elements in this compound are:	1.	2.	3.	4.
Symbol				
Atomic Number				
Family/ Group				
Period				
Electron configuration (Atomic # 1-20 only)				
Valence electrons				
Number of protons, neutrons, electrons				
Metal, non-metal, or metalloid? Some key properties?				
Draw Lewis structure, including bonding				

Write the following sentence as a balanced chemical equation: Mustard gas is an organic compound that is created by combining sulfur dichloride with ethylene.

What type of chemical reaction is this? (Synthesis, decomposition, etc.)

What is the molar mass of mustard gas?

There are several different methods of making mustard gas. Another is shown by the equation:



What is the correct nomenclature (name) for the binary compound PCl<sub>3</sub> that is used in mustard gas production?

If 10 moles of mustard gas were used in a single shell on a WWI battlefield, how many moles of PCl<sub>3</sub> were needed to produce that amount?