

7.6 Gun cotton (Combustion of cellulose nitrate)**Subjects:** Thermodynamics, Kinetics, Equilibrium**Description:** A seemingly normal piece of cotton is ignited. It will immediately ignite and burn with a flash leaving little residue.**Materials:**

For Demo:	For preparation of new gun cotton:
ring stand with metal base wood splint on a long rod matches* prepared gun cotton regular cotton (optional for comparison)	70 mL Concentrated (18M) sulfuric acid (H ₂ SO ₄) 30 mL concentrated (16M) nitric acid (HNO ₃) 250 mL 1M sodium bicarbonate (NaHCO ₃) 250 mL beaker ice bath 5 g absorbent cotton tongs paper towels
*due to the explosive nature of gun cotton, the matches are stored separately. They are located in the top drawer opposite the shelves.	

Preparation of Gun cotton:

1. In an ice bath in the 250 mL beaker, carefully mix the acids.
2. Divide the cotton into 0.7 g pieces and add the pieces to the beaker, one at a time for one minute each with tongs.
3. Rinse each piece in 3 to 4 successive baths of 500 ml water. Use fresh water for each piece.
4. Immerse each piece in NaHCO₃ to check for residual acid. If significant bubbling occurs, rinse the piece again.
5. Squeeze dry and spread on paper towels to dry.
6. Store cotton in an air-tight plastic container.

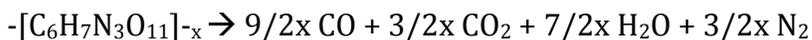
Procedure:

1. Place a piece of gun cotton on the metal base.
2. Light the end of a wood splint and touch it to the gun cotton to ignite it.
3. The gun cotton will burn quickly leaving only a small amount of unburned residue. Most of the material is converted to gaseous products.
4. (Optional) Place a piece of regular cotton on the base of a ring stand. Light the piece with a lit wood splint. It will burn slowly. Extinguish.

Discussion:

Cellulose is a polysaccharide found in plants and is similar to starch. The concentrated sulfuric acid is a dehydrating agent and removes the -OH groups on

the cellulose. Nitric acid replaces the lost alcohol groups by adding several highly reactive nitrate groups to give trinitrocellulose or cellulose trinitrate, which contains 12.5-13.5% nitrogen. The decomposition of gun cotton is initiated by the heat from the splint, which adds enough energy to start the reaction. The reaction is given below:



Enough oxygen is contained in the compound for complete conversion to gaseous products.

Safety: Nitric and sulfuric acids are very strong acids and powerful oxidizing agents, which can cause severe burns. Sulfuric is also a powerful dehydrating agent. Spills should be neutralized with sodium bicarbonate and rinsed thoroughly.

The mixing of the two acids is extremely hazardous and must be performed in the hood. Mix the acids very slowly in an ice bath.

Cellulose trinitrate is extremely flammable and can explode if ignited in an enclosed space. Store away from ignition sources.

Disposal: Very little residue is left after ignition of the gun cotton. The small amount of carbonaceous residue can be discarded in the waste.

References:

1. B.Z. Shakhashiri; *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; Wisconsin; Volume 1; 1987; p. 43-45
2. Turner, Everett. University of Massachusetts, Amherst. 1979
3. L. Summerlin, C. Borgford, J. Ealy; *Chemical Demonstrations: A Sourcebook for Teachers*; Volume 2; 1987; p. 103-104