

# CHEMISTRY

## Prelim Chemistry: Research on Element 'Gold'

---

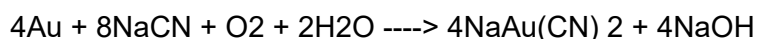
- 1. Identify an element from one of the 'spheres' in our environment. Give industrial details of the extraction process, highlighting how the physical and chemical properties of the substance underpin the suitability of the extraction process.**

Gold is the element 'Au' that is commercially extracted from the environment. It is a highly valued and well-known element that is suspected to one of the first metals used by humans. Gold has many uses in society and people have been extracting and using gold for many years, though extraction processes have evolved over the years.

The original extraction process involved panning which involved filtrating gold from the rocks and water in riverbanks. This process worked due to gold's high density and the yellow colour common to gold. This helps with the visibility of the element in the mixture. Though, panning has been phased out due the introduction of the Cyanide process.

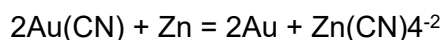
The Cyanide process was developed by John Stewart MacArthur in 1887 after it was previously discovered that cyanide dissolves gold. Gold has very low solubility and can only be dissolved by aqua regia (a mixture of hydrochloric and nitric acids) and cyanide. This reactivity of gold to these certain solutions is what enables extraction. The process involves extracting gold from ores by dissolving in a dilute solution of sodium-, potassium- or calcium-cyanide. Gold can also be found in small particle sizes and it is not chemically inert which allows gold to be dissolved in the cyanide solvent, though particle size does effect the time taken for dissolution.

The chemical equation for this reaction is known as the Elsner Equation:



The unnecessary solids are separated and then the gold is recovered by adding powdered zinc, causing the gold to precipitate. This involves recovering the gold precipitate by a very fine filter.

This is known as the Merrill-Crowe zinc precipitation process.  
The chemical equation for zinc reacting with the cyanide solution is:



Gold extraction by the cyanide and precipitation processes is now a worldwide practice due to the percentage of recovery being 98%.

- 2. Discuss issues associated with wastes from the processes used. Discuss how any environmental disturbances are minimised.**

The Cyanide process is highly controversial due to the toxic nature of cyanide. As with most things, waste is a result of the process. Waste has to go somewhere, which is an issue when dealing with a solution as toxic as cyanide. The toxicity is determined by the form and concentration of the cyanide. Gold extraction waste is usually sent to a tailing pond. A tailing pond is where material is left to cause settlement of the solid particles. An issue regarding the tailing pond is the toxic levels of the water. Tailing ponds need treatment for three years after the deposition finishes taking place before water standards are acceptable.

The process has been in use in the mining industry for over a hundred years it has been found that there are no long term unfavourable effects from the use of cyanide. Though, there are short term effects and this has been shown through a number of cyanide spills. In Baia Mare, Romania there was a spill and cyanide was released into the Tisza and Danube Rivers – this killed almost all of the life in the rivers. Fish are affected the most but cyanide spills cause a breakdown of the entire food chain. The surrounding environment is highly disturbed but cyanide breaks down quickly in sunlight causing the damage to begin improving immediately.

A way to minimise the effects of cyanide is to use an air detoxification circuit which changes the cyanide to cyanate which is less toxic, the cyanate is then released into the tailing ponds. This air detoxification circuit is used around the world now due to its success. Another way to minimise environment disturbances is to have a water treatment plant. The plant will treat the water in order to destroy the cyanide. Evidence shows that this solution has been working. In an area where treatment water was released, the fish in the water have been monitored. The outcome is that there have been no major undesirable effects to the numbers.

Therefore though there were originally some issues regarding waste, tailing ponds have been the solution and when air detoxification circuits and water treatment plants in place then environmental disturbances are minimal.

- 3. Select two main uses of the element you have selected and described how the properties of the substance make it suitable for the applications you have chosen.**

#### ***Jewellery***

78% of the gold mined today is used in jewellery. Gold is a popular choice for the manufacture of jewellery because it has the sought-after yellow colour and high lustre. This makes it an aesthetically pleasing metal. Gold is tarnish- and corrosion- resistant which makes it an excellent metal for every-day use. Pure gold is very soft; therefore gold is often alloyed with copper, silver, platinum etc to increase the durability. Gold alloys decrease the mass and are stronger and more resistant to tarnish. Gold carats represent the amount of pure gold in the gold alloys. Gold is malleable and ductile; it is easily hammered into thin sheets and can be drawn into wires, significant properties for jewellery manufacturing. The properties of gold make it highly suitable for jewellery and tradition and the high value of gold make it the most popular metal for jewellery.

#### ***Electronics***

Industrially, gold is an important metal because its properties make it perfect for many electronic purposes. The low voltages and currents of electronic devices make them very vulnerable to interruptions due to corrosion and tarnish. Gold's high corrosion – and tarnish – resistance renders it a perfect metal for electronics because the circuits can remain corrosion – and therefore interruption- free. Gold also has the high electrical conductivity necessary to send the currents. Gold can be found in most electrical devices today: in televisions, connecting wires, calculators, mobiles and more. Devices with gold in them are highly reliable due to its properties.

\*In most mobiles there is about 50 cents of gold, with about a billion mobiles made a year – this un-recycled gold adds up to a significant amount.

- 4. Describe the impact of your chosen element on society.**

Gold has been around for thousands of years and has a number of uses including electronics, jewellery, medicine, computers and dentistry. The properties of gold make it very useful and when alloyed it has become a popular choice of metal. Though, gold is rare and of high monetary value which has forced people to find alternative metals to gold.

Gold has made many technological advances possible including in electronics and computers. In medicine gold cures 'Lagophthalmos' (when someone can't close their eyes completely) and a number of other conditions. In dentistry gold's properties allow it to be used for fillings, bridges, etc because it is non-allergenic and soft enough to shape.

The impact of gold on society, is due to its high value gold is a universal currency, especially during unstable times. People turn to gold as a sustainable currency to trade with around the world. Though, because of its high monetary value and use as a currency, gold causes conflict and war – it is highly sought after amongst many groups of people all around the world.

Gold also has an interesting effect on society and its dwellers because of its value. It gives people a feeling of self worth when they are able to display their gold to the world. Gold has become a symbol of wealth and status in society. It has been approximated that the gold in the world, refined, would only make up a cube with side length of 18 metres: 324 m<sup>2</sup> of pure gold in the entire world.

Gold has impacted on society socially, economically and scientifically. The properties of gold has enabled it to be of use in many areas, the value of gold has allowed it to become a global currency and the rarity has caused it to be status icon. Gold is one of the most important metals in the world.