GOLD FACTS

What is Gold?

Gold is a heavy, yellow, metallic chemical element. It is a precious metal, with a high degree of ductility and malleability, that is used in the manufacture of a wide range of products including jewelry, electronics, and coinage

How is Gold Weighed?

The weight of gold or gold articles is usually expressed in troy ounces.

1 troy ounce = 1.097 ordinary ounce
1 tonne = 32,151 troy ounces

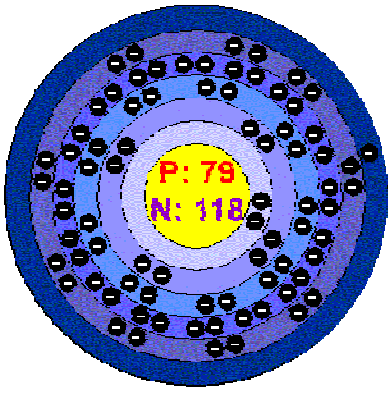
How is Purity Measured?

The purity of gold articles is generally described in three ways:

PERCENT *(parts of gold per 100)*	FINENESS *(parts of gold per 1000)*	KARATS *(parts of gold per 24)*
100 percent	999 fine	24 karat
91.7 percent	917 fine	22 karat
75.0 percent	750 fine	18 karat
58.3 percent	583 fine	14 karat
41.6 percent	416 fine	10 karat

Properties of GOLD

Gold, (symbol Au) has an atomic number of 79 i.e. each gold atom has 79 protons in its nucleus. The atomic mass of the gold atom is 196.967 and the atomic radius is 0.1442nm. Interestingly this is smaller than would be predicted by theory. The arrangement of outer electrons around the gold nucleus is based on 14 4f shell electrons, 10 5d shell electrons and a single 6s shell electron (i.e. [Xe]4f145d106s).



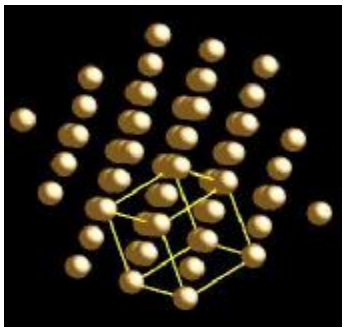
The arrangement of these electrons is related to gold's characteristic yellow colour. The colour of a metal is based on transitions of electrons between energy bands. The conditions for the intense absorption of light at the wavelengths necessary to produce the typical gold colour are fulfilled by a transition from the d band to unoccupied positions in the conduction band. The addition of alloying elements has a profound effect on colour of a gold based alloy. Adding nickel or palladium, for

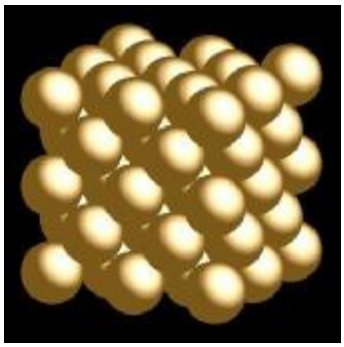
Courtesy: World Gold Council

example, has a whitening effect.

Whilst the number of protons in a gold nucleus is fixed at 79, the number of neutrons can vary from one atom to another giving a number of isotopes of gold. However, there is only one stable non-radioactive isotope accounting for all naturally found gold.

The crystal structure for metallic gold is face centred cubic FCC This crystal structure contributes to gold's very high ductility since FCC lattices are particularly suitable for allowing the movement of dislocations in the lattice. Such dislocation movement is essential for achieving high ductility.





Physical Properties:

The density of gold (19.3 gcm^{-3}) depends on both its atomic mass and the crystal structure. This makes gold rather heavy compared to some other common materials. For example, aluminum has a density of 2.7 gcm^{-3} and even steel's density is only 7.87 gcm^{-3}.

The melting point of pure gold is 1064°C, although when alloyed with other elements such as silver or copper the gold alloy will melt over a range of temperatures. The boiling point of gold, when gold transforms from the liquid to gaseous state, is 2860°C.

The ability of gold to efficiently transfer heat and electricity is bettered only by copper and silver, making it indispensable in electronics for semi-conductors and connectors in computer technology. The **electrical resistivity** of gold is 0.022 micro-ohm m at 20 °C. The **thermal conductivity** is 310 W m^{-1} K^{-1} at the same temperature. The corrosion resistance of gold is perhaps one its most useful properties. Electrode potentials are a useful method for representing the tendency of a metal to corrode. Electrode potentials are measured with reference to hydrogen and an electrochemical series can be prepared for metals as indicated below. Not surprisingly, gold is at the top of the series indicating its high **corrosion resistance**. In practice, it is corroded only by a mixture of nitric and hydrochloric acid (aqua regia). In everyday use gold does not tarnish. Gold only dissolves in cyanide.

Electrode potential (V)	Element	
+1.5	Au	Gold
+0.8	Ag	Silver
-0.4	Fe	Iron
-0.8	Zn	Zinc
-1.66	Al	Aluminium

Mechanical properties

Gold is extremely **malleable** (the extent to which a material can undergo deformation in compression before failure). In the annealed state it can be hammered cold into a translucent wafer 0.000013 cm thick. One ounce of gold can be beaten into a sheet covering over 9 square meters and 0.000018 cm thick.

Gold is also ductile (degree of extension which takes place before failure of a material in tension) and one ounce can be drawn into 80 km (50 miles) of thin gold wire (5 microns diameter) to make electrical contacts.

The Young's **modulus of elasticity** of a material is related to rigidity or stiffness and is defined as the ratio between the stress applied and the elastic strain it produces. Gold has a Young's modulus of 79 GPa which is very similar to silver, but significantly lower than iron or steel.

Hardness is defined as the ability of a material to resist surface abrasion. The relative hardness of materials has long been assessed using a list of materials arranged in such order that any material in the list will scratch any one below it. Thus, diamond the hardest substance known, heads the list with a hardness index of 10 whilst talc is at the bottom with a hardness index of 1. On this scale, gold has a value of 2.5 to 3 i.e. it is a soft metal. For more accurate measurements the Vickers hardness and Brinell measurements are used and gold has a value of approximately 25Hv in the annealed condition.

Summary:

The summarized properties of annealed Gold are shown in the Table below:

Property	
Atomic weight amu	196.97
Atomic number	79
Number of naturally occurring isotopes	1
Melting point °C	1064
Crystal structure	FCC
Density @ 293 K gcm^{-3}	19.3
Thermal conductivity W m^{-1} K^{-1}	310
Electrical resistivity micro-ohm m at 20°C	0.022
Youngs modulus E GPa	79
Hardness Hv	25
Tensile stress MPa	124
0.2% proof stress MPa	30
Poissons ratio	0.42

Courtesy: World Gold Council