Diamonds: The hardest of minerals

What do a glittering diamond and a lead pencil have in common? Diamonds are very hard and the graphite of the pencil's tip is very soft. These two different substances contain a wonderful proof of creation called carbon.

A rough, unpolished diamond is the hardest of all minerals.(1) For this reason, a crystal diamond is used to cut and to drill all kinds of material and is also used as an abrasive to smooth surfaces. (2)

Hardness is the resistance of a mineral to scratches from outside forces; it is easy to recognize minerals by this trait. By scratching one mineral with another, their relative hardness can be determined. Scientists use a point system to designate the hardness of all minerals. They rate diamonds with the highest ratio of ten over ten. So, what makes diamonds so hard?

It is very interesting that the soft, breakable graphite in a pencil tip is made up of the same atoms as a diamond. Graphite is composed of the same carbon atoms as a diamond. But, while one is very soft, the other is extremely hard. One is as black as a lump of charcoal; the other may be sparkling bright. One is commonly found in nature; the other is rare. For all these reasons, diamonds are much more valuable than graphite. How is it then, that carbon atoms can be so different from one another?

Carbon: The Foundation of Life
(The Value of Diamonds is Determined by its Atoms)

Before we consider the differences, we must speak about the carbon atoms that make up a diamond. The carbon atom is very important for living creatures. Nevil Sidgwick, the English chemist, states the following in his book, *Chemical Elements and Their Compounds*:

> *Carbon is unique among the elements in the number and variety of the compounds which it can form. Over a quarter of a million have already been isolated and described, but this gives a very imperfect idea of its powers, since it is the basis of all forms of living matter.* (3)

The class of compounds formed exclusively from carbon and hydrogen are called hydrocarbons. This is a huge family of compounds that include natural gas, liquid petroleum, kerosene, and lubricating oils. The hydrocarbons ethylene and propylene form the basis of the petrochemical industry. Hydrocarbons like benzene, toluene, and turpentine are familiar to anyone who has worked with paints. The naphthalene that protects our clothes from moths is another hydrocarbon. Hydrocarbons combined with chlorine or fluorine form anesthetics, which are the chemicals used in fire extinguishers and the Freon used in refrigeration.

As one can see, carbon is very important; it is what makes the diamond a rare mineral. A diamond has no rival for being the finest example of a crystalline structure in the world. The carbon atoms that give the diamond crystal its hardness have an ideal geometric design. Graphite is also formed from carbon but its atoms are not ordered as in a diamond. Scientists describe this difference by the world *allotropy*.

The Concept of Allotropy

The difference, in the arrangement of space, in the atoms that make up the structure of an element is called *allotropy*. The atoms that produce the structure are called allotrope atoms. We can explain this with the following example:

Imagine that we have bought three loads of 10,000 bricks each and that all these brinks are identical to one another. We have sent these brinks to three different bricklayers who will each build a wall to their own design independently of the others.

-Would the walls be identical?
-Would they all have the same sturdiness?
-Would the artistic arrangement of the bricks be similar?

If the answer to these questions is yes, the wall will not be allotropic.

If the answer to these questions is no, we can call the walls allotropic.

Oxygen and ozone are allotropes of oxygen atoms.

Diamonds, graphite, and amorph carbon are allotropes of carbon atoms.

White phosphorus and red phosphorus are allotropes of phosphorus atoms.

Rhombic sulfur and monocline sulfur are allotropes of sulfur.

Characteristics of Allotrope Atoms:

- The atom and its atomic number are the same.
- Their molecular geometry is different.
- They have different inclinations to enter chemical reactions, but the compounds formed by such a reaction are the same.
- The molecular sturdiness is different.

Some physical characteristics of diamonds and graphite have been explained as follows:

All the qualities that give diamonds their value are related to conditions that emerge during their formation. For the natural formation of a diamond, excessive heat and pressure are needed. Diamonds are formed deep in the earth’s crust. Bits of melted diamond may erupt to the surface and freeze but this happens very rarely. This is the reason why there are very few diamond deposits in the world and why the number of rich deposits is very small.

The natural structure and formation of diamonds has shown scientists the way to produce artificial diamonds. Diamonds have been produced in experiments in which graphite has been subjected to 100 thousand atmospheres of pressure in 3000-degree heat. However, synthetic diamonds are not as valuable as natural ones but because of their hardness, they are used as industrial abrasive.

Where Diamonds are Used:

Three Kinds of Diamonds:

1.) Original Diamonds: These are the original, valuable diamonds. They are measured in karats. One karat equals 0.205 grams. They are used as jewelry.

2.) Bort: A semi-transparent and striated diamond. It is harder than an original diamond and it is used to carve high quality diamonds. In the drilling industry, these diamonds are used for drill bits.

3.) Carbonado: This is a black, uncarved diamond. It is harder than an original diamond and it is used in the manufacturing of drilling equipment.

As Sidgwick has pointed out, the carbon atom, which has only six protons, six neutrons and six electrons is a genuine/true miracle. The fact that a difference in the arrangements between the atoms produces such differences that yield such incredible possibilities for human beings is enough to understand that these formations come from the grace of Allah. Like every proof of creation in nature, Allah has created carbon and diamonds with all their qualities.

> **What is in the heavens and in the Earth belongs to Allah. Allah encompasses all things.** (Qur'an, 4:126)

	Diamonds	Graphite
Structural Atom	Carbon	Carbon
MELTING POINT	High	Low
Molecular Arrangement	Straight Square	Straight Hexigon
Hardness	Hard	Soft
Permeability to Light	permeable	impermeable

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3 Nevil V.Sidgwick, The Chemical Elements and Their Compounds, vol.1, Oxford: Oxford University Press, 1950, s.490
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