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FROM CHAOS TO COSMOS, FROM COSMOS TO CHAOS

Look at the floods of sand,

They never stop and rest.

Look how the world suddenly ends,

How it founds a new world at the best.

Rumi (1207-1273)

As Rumi[1] said, every disorder/chaos underlies a new order/cosmos. Scientists have discovered in the last century that each sand grain, billions of which spread chaotically over the Earth, had indeed a very ordered structure.

Depending on the local rock sources and conditions, sand is composed of tens of different minerals. As is known, the most common constituent of sand in inland continental settings and nontropical coastal settings is silicon dioxide (SiO_2), usually in the form of quartz (Fig. 1). There is a projection of quartz's structure in Fig. 2. We can imagine a reiteration from the perspective of the figure. The red balls represent oxygen atoms and the gray balls silicon atoms. The structure's part that is shown in a frame is its periodic repetitive part. This frame (two-dimensional cell) can be moved to every part of the figure in parallel with itself, and hereby the top of the frame will be suitable for non-diversifying points. Crystal compounds can be determined with this type of three-dimensional frame. It can be called a unit cell too. The size of the unit cell's edges or angles between the edges can be changed. Resolving the structure of compounds determines the size of unit cells, edges, angles between the edges, and how atoms settle into the cell.

Linus Pauling (1901-1994), who was one of the most famous chemists of the last century, suggested showing the structure of crystals by a different method. According to this method, it is needed to tie atomic points with straight lines in inorganic components. Let us compare the description of silicon dioxide's structure, which was drawn according to this method (Fig. 3), with the other description. As we can see, all gray balls (silicon atoms) form a tetrahedron with the nearest red balls (oxygen atoms). Projections of polyhedrons on a plane become polygons. As a result, projections of crystal structures on a plane generally look like patterns made of these types of polygons. In this type of figure, the position of atoms is indicated on the polygons' center or where lines merge.

1 Mevlana Celaleddin-i Rumi was a very famous philosopher and sufi-mystic who lived in the 13th century and whose tomb is in Konya, Turkey. For further information about him see: "Rumi" at https://en.wikipedia.org/wiki/Rumi and "Mevlânâ Celâleddîn-i Rûmî" https://islamansiklopedisi.org.tr/mevlana-celaleddin-i-rumi.

Amazing views of the Gobi desert under the night starry sky.

In the description of the crystal structure of quartz mineral (silicon dioxide – SiO_2), the points where tetrahedrons (squares) cross are the position of oxygen atoms and the centers of tetrahedrons (squares) are the position of silicon atoms.

Khudu Mamedov (1927-1988) determined that this description of the crystal structure of silicon dioxide was similar to a pattern in a mausoleum that was built in Barda, Azerbaijan, in 1322. In addition, he wrote that the same pattern was seen in an older monument from the 13th century in Mardin [1]. The carved pattern on the stone is in Shehidiye Madrasa, which features architectural work from the Artuqid period [2].

Since the Middle Ages, this pattern has been encountered in Anatolia. For example, the Green Tomb in Bursa is one of them (Fig. 4). The same pattern is frequently observed in architectural monuments in Central Asia [3].

The mineral berlinite, with the formula $AlPO_4$, has a crystal structure that is depicted similar to that of quartz. The difference between quartz (whose constituent is SiO_4 tetrahedrons) and berlinite is that the latter has Al and P atoms instead of Si in tetrahedrons. They are shown in different colors in Fig. 5.

The mineral cristobalite is a high-temperature polymorph of silicon dioxide, meaning that it has the same chemical formula, SiO_2, but a distinct crystal structure. Both quartz and cristobalite are polymorphs with all the members of the quartz group (coesite, tridymite, stishovite, etc.). The pattern in Fig. 6 is a structural depiction of ⍰-cristobalite. At the same time, it is one of the descriptions of laminal silicon-oxygen radicals, which are found easily in nature.

We can see a similar pattern on 7000-year-old ceramics in Tabriz Museum (Fig. 7). The same pattern garnishes the 12th century Seljuk Palace in Ani (Kars, Turkey, see Fig 8). Tile versions of this pattern can be seen in Konya (Mevlana Museum, see Fig. 9; Sahib Ata Mosque) and in Bursa (Grand Mosque and Green Mosque) [4]. I had a chance to see these patterns on architectural monuments in Tehran and Shiraz during my trip to Iran in 2013 (Fig. 10 and 11).

Furthermore, the same pattern garnishes a miniatures from the15th [5] and 16th century [6]. I want to draw your attention to the formation of a similar pattern in a basket woven by American Indians [3].

Arkose, which is formed by weathering and erosion of granitic rock, consists of quartz particles and feldspars. Feldspar is a mineral group, constituting 60 percent of the Earth's crust. We can see that one mineral of this group, orthoclase ($KAlSi_3O_8$), has a crystal structure [7] that resembles the Selsebil mosaics of Mardin Marufiye Madrasa [4].

This pattern, which is also seen in Konya Mevlana Museum (Fig. 12) and in Bakhchisaray Palace, Crimea (Fig. 13), is just the same as the crystal structure of the mineral erionite [$(Na_2,K_2,Ca)_2Al_4Si_{14}O_{36}\cdot 15H_2O$] [8], which exists in Turkey too. Moreover, the mineral chabazite [$(Ca,Na_2,K_2,Mg)Al_2Si_4O_{12}\cdot 6H_2O$], which is found in India, Iceland, Ireland, Bohemia, Italy, Germany, Arizona, and New Jersey, has the same structure.

Masjid-e Jameh (Isfahan), an 11th-century monument of the Seljuk Empire, and the mirror work (Fig. 14) of the Shah Abdol Azim Shrine (Tehran), a 19th-century monument of the Qajar Empire, have a pattern similar to ferrierite [$(Na,K)_2Mg(Si,Al)_{18}O_{36}(OH)\cdot 9H_2O$], found in Canada [9].

Black sands found in different regions of the world essentially consist of dark-colored heavy minerals, like hematite (Fe_2O_3), ilmenite ($FeTiO_3$), and magnetite (Fe_3O_4). Scientists determined that there are more than 50 minerals in these sands. By presenting patterns of the crystal structures of spinel and chromite minerals, which are isostructural with magnetite minerals, in two different projections, I want to show that there are tens of patterns in a handful of sand. (Fig. 15 and 16)

Khudu Mamedov has named such patterns "crystallographic patterns" due to their resemblance to the structures of crystals [10]. As we know, analyzing the crystal structure of materials by X-rays started almost a century ago. Therefore, how did these people, who had no idea about crystal structures, create the same patterns as the crystal structures of materials centuries ago? What is the reason for the similarity between crystal structures and crystallographic patterns? We can answer these questions that we always face as follows. The reason for the similarity may be accounted for by some formation styles. Humans, as a part of the cosmos, can create the same patterns intuitively by using the creativity principles of Mother Nature. The similarity of patterns to some crystal structures enables us to reach the following conclusions: mankind may use the principles from which nature was created, and he may achieve a resemblance to the creation of nature in ideal form; mankind cannot create anything that does not have a prototype in nature.

I want to finish the journal version of my article published in Elvira Wersche's book [11] with verse by William Blake (1757-1827):

To see a World in a Grain of Sand

And a Heaven in a Wild Flower,

Hold Infinity in the palm of your hand

And Eternity in an hour.

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Hacali Necefoğlu

Fig. 1 Quartz (SiO_2)

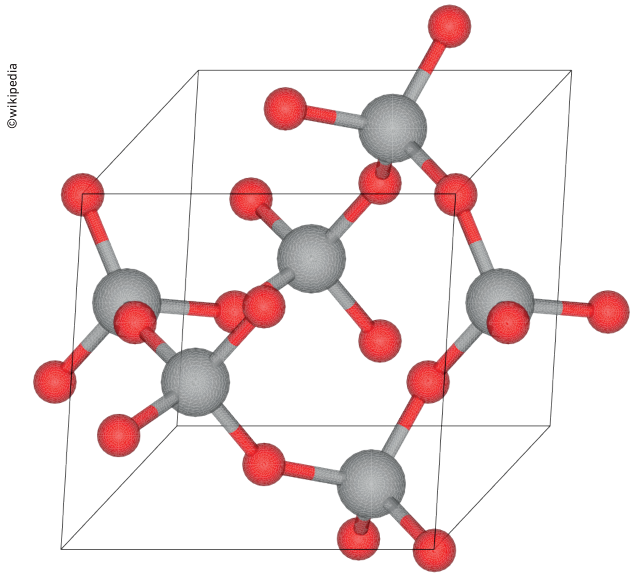

Fig. 2. Structure of quartz.

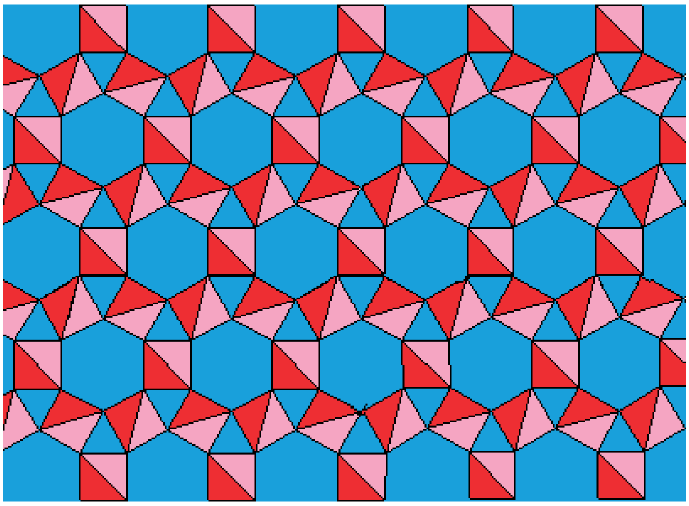

Fig. 3. Structure of quartz (by Pauling method).

Fig. 4. Green Tomb, Bursa, Turkey.

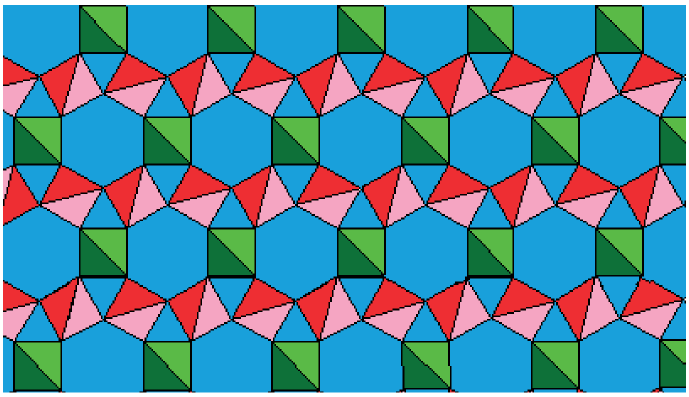

Fig. 5. Structure of Berlinite.

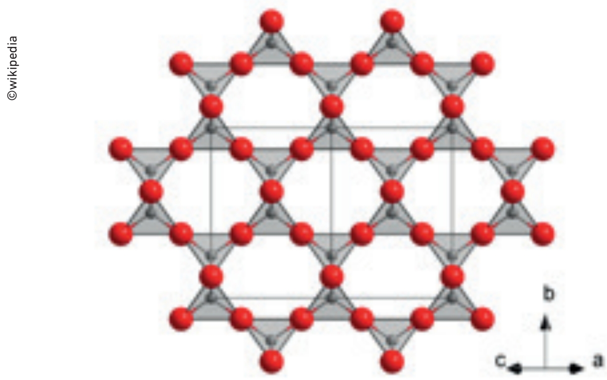

Fig. 6. Structure of Cristobalite.

Fig. 7. Ceramic from Azerbaijan Museum (Tabriz, Iran).

Fig. 8. Decoration from Ani (Kars, Turkey).

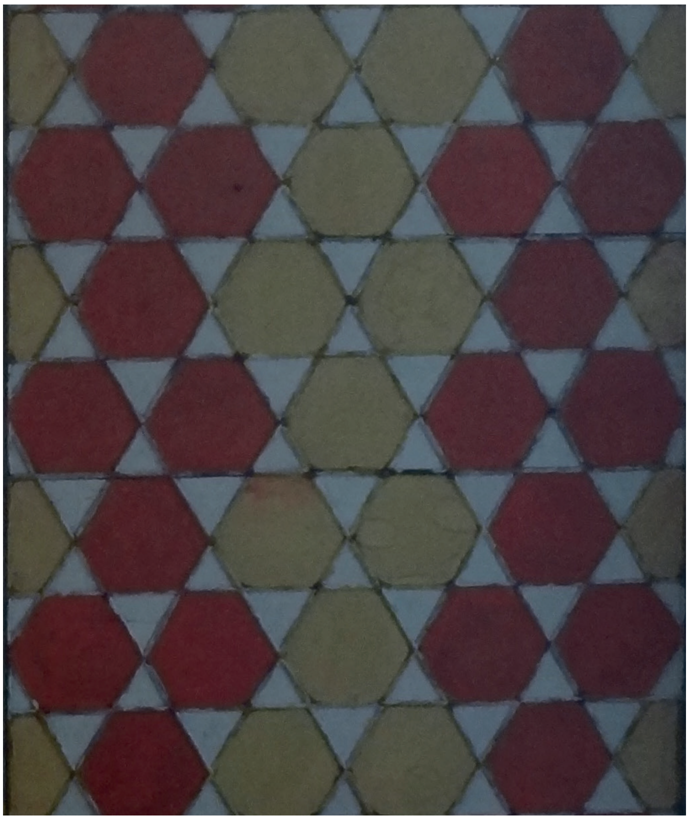

Fig. 9. Decoration from Mevlana Museum (Konya).

Fig. 10. Shah Abdol Azim Shrine (Tehran).

Fig 11. Shah Cheragh Mosque (Shiraz).

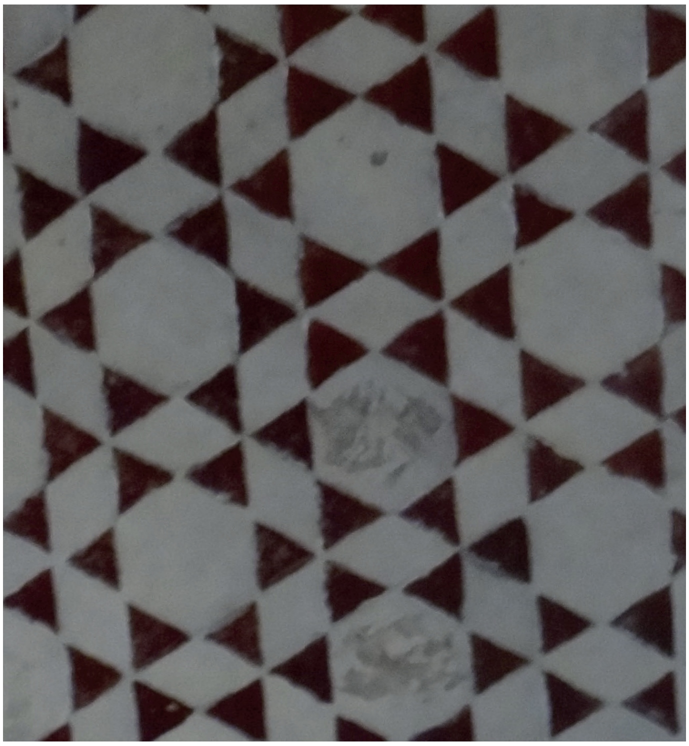

Fig. 12. Decoration from Mevlana Museum.

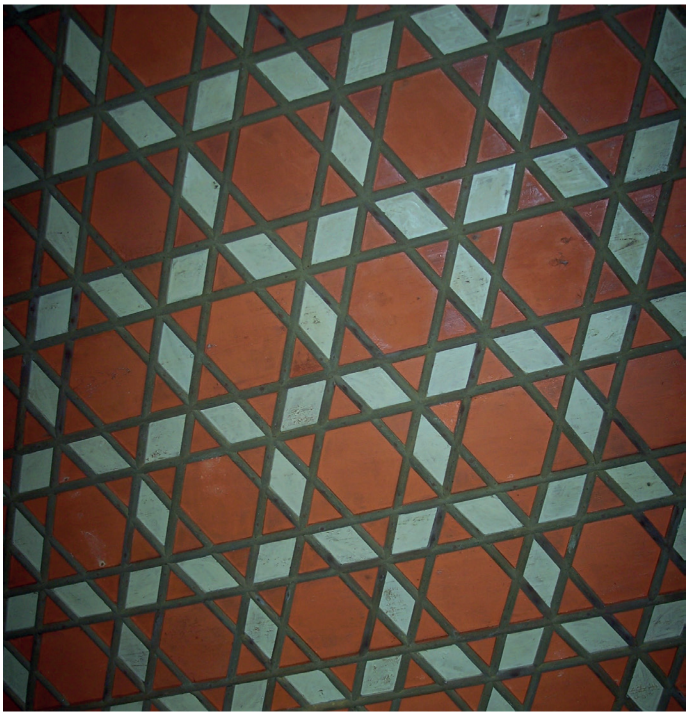

Fig. 13. Decoration from Bakhchisaray Palace, Crimea.

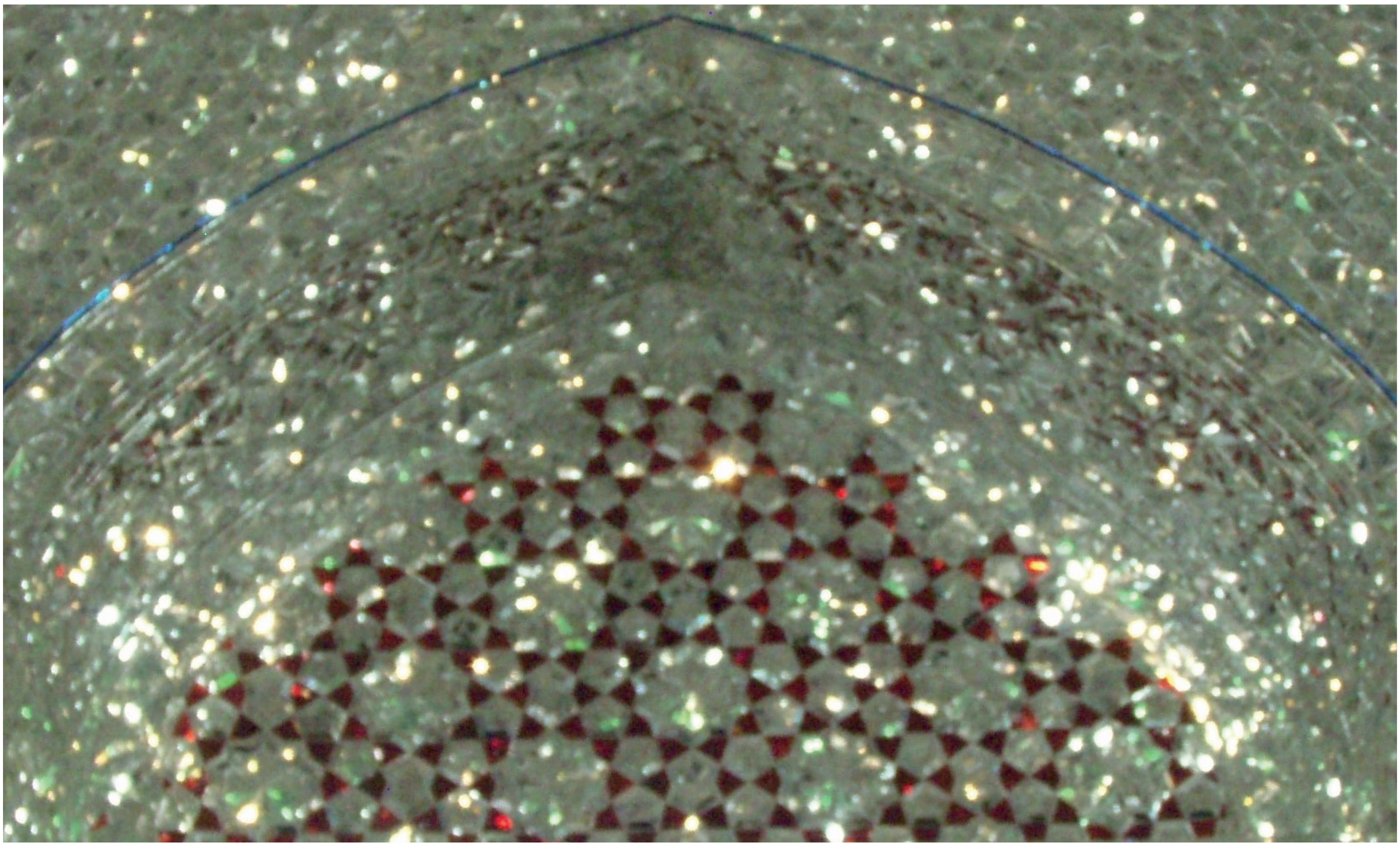

Fig. 14. Shah Abdol Azim Shrine (Tehran).

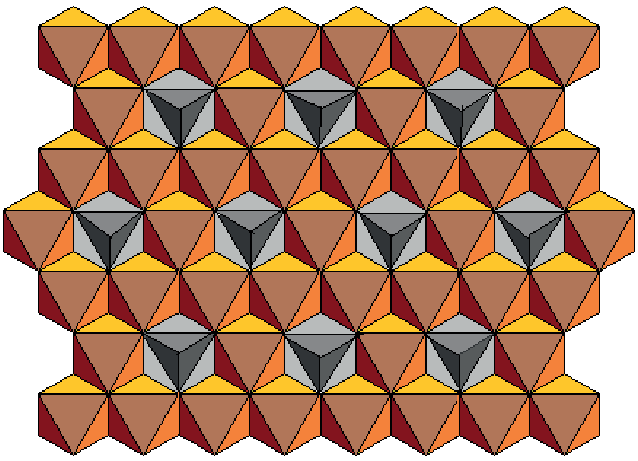

Fig. 15. Spinel structure.

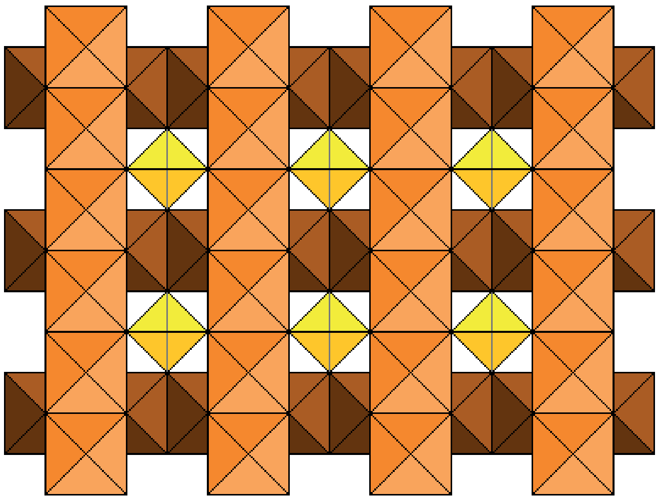

Fig. 16. Spinel structure.

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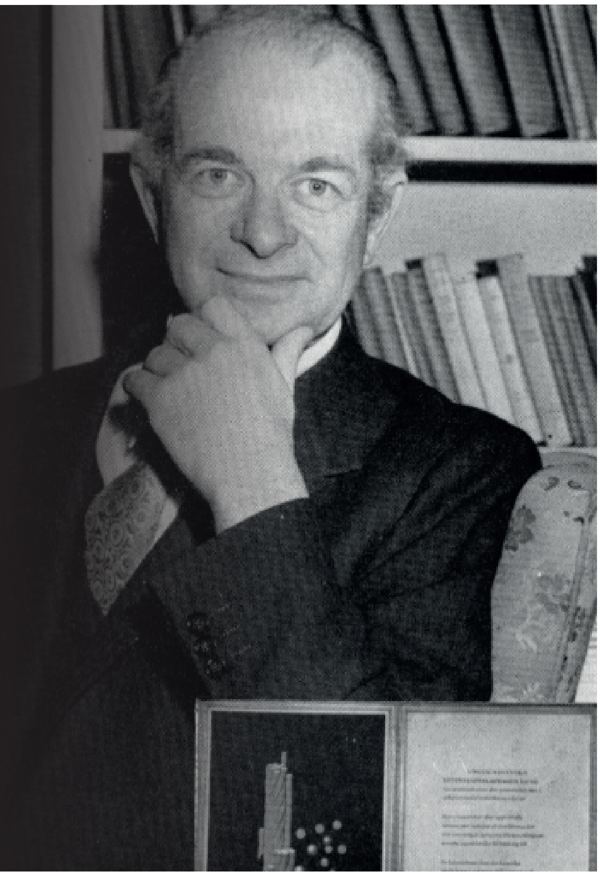

LINUS PAULING (1901–1994), QUANTUM CHEMISTRY AND MOLECULAR BIOLOGY

Linus Pauling, considered one of the 20 greatest chemists of all time, is regarded as the father of quantum chemistry and molecular biology. Pauling received the Nobel Prize in Chemistry in 1954 and then the Nobel Peace Prize in 1962 for his anti-war efforts. Pauling was born in Portland, Oregon, USA in 1901, and when he was in high school he created a chemistry laboratory in the basement of his home. He took the necessary courses to graduate from high school, but the high school administration did not give him his diploma because he had not taken citizenship courses. Oregon State University enrolled him without the need for a diploma. When Pauling received the Nobel Prize, the high school administration gave him his high school diploma 47 years later. Pauling, who lost his father at the age of 10, worked as a laborer at the port so that he could study at university. The university administration recruited him as a chemistry assistant because of his chemistry knowledge and superior intelligence when he was in his third year. After graduating from university, he completed his PhD on examination of the structures of crystalline materials at the California Institute of Technology as a high honor student in 1925. As a postdoctoral researcher in Europe, he worked with Niels Bohr, Erwin Schrödinger, and Arnold Sommerfeld, the world's leading names in quantum mechanics.

Linus Pauling (1950s): Father of Molecular Biology

Linus Pauling said "When I was a student, I was very curious about the state of electrons in atoms and the distances between atoms when they form molecules and new states of electrons." In Europe, Pauling, who studied quantum physics closely, later determined the principles of quantum chemistry, becoming the founder of this scientific field. He explained in 1932 that atoms had different forces to attract electrons in covalent bonds that they created by using each other's electrons while forming molecules. He called this force of attraction electronegativity and prepared an electronegativity table of the elements by performing the necessary calculations. It was understood thanks to Pauling why the carbon atom sometimes forms coal and sometimes forms diamonds, and carbon sometimes bonds to four atoms, sometimes to three, and sometimes to two. This feature of carbon became clear as a result of the hybridization concept Pauling explained in 1931. Pauling explained that the orbitals in carbon atoms hybridize as sp^3 and make 4 carbon–hydrogen bonds in the methane molecule of the same length and equidistant from each other. In this way, the reason why carbon orbitals can hybridize as sp^3, sp^2, or sp form creating single, double, or triple bonds in organic compounds was easily understood. Pauling made a revolutionary discovery in medicine in 1949. As is known, in the disease called sickle-cell anemia, circular red blood cells take the shape of a sickle due to an abnormality in the hemoglobin molecule. This prevents blood flow in the vessels, causing problems in the organs. Pauling discovered that this disease was caused by a genetic defect in the structure of the hemoglobin molecule and became the father of molecular biology and molecular genetics. Pauling, who discovered that the structure of proteins is spiral-shaped in 1951, explained the structure of DNA as a triple spiral, but it was soon proved to be a double spiral. Pauling did not participate in the construction of the atomic bomb. He was unable to attend a scientific meeting in England in 1952 when his application for a passport was denied for a period by the US administration because he took part in anti-nuclear protests.

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FAMOUS TURKISH SCIENTIST IN THEORETICAL CHEMISTRY: OKTAY SINANOGLU (1935–2015)

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Sinanoğlu was born on February 25, 1935, in Bari, Italy. After he graduated from high school, he won a scholarship for education in chemistry in the USA. In 1956, he got his bachelor's degree from the University of California at Berkeley in chemical engineering with highest honors. The following year, in only eight months, he completed a master's degree on "Viscosity of Polar Vapor Mixtures" [1] at the Massachusetts Institute of Technology (MIT) with the highest degree. He returned to Berkeley, where he received his Ph.D. degree in "Intermolecular Forces and Statistical Mechanics" [2] in theoretical chemistry under the guidance of Kenneth Pitzer in 1959. Sinanoğlu was appointed to Yale University in 1960 and promoted to associate professor for his work on the "Many-electron Theory of Atom and Molecules" providing a powerful approach to the electron correlation problem [3-5]. In 1963, at the age of only 28, Sinanoğlu was appointed full professor of chemistry, and he thus became the youngest full professor in Yale's 20th-century history.

Sinanoğlu, known as the Turkish Einstein, provided the greatest scientific contributions to world science literature in both theoretical chemistry and molecular biology with theories he developed such as the many-electron theory of atoms and molecules (which is the best known of his works), solvophobic theory [6,7], network theory of coupled chemical reactions [8], micro-thermodynamic surface tension [9], and valency interaction formula theory [10].

Sinanoğlu made significant contributions to quantum mechanics throughout his life. The most important of them is his development of a theory about the electronic structure of molecules. While the behavior of electrons is governed by the Schrödinger equation, this equation is essentially impossible to solve except for in systems with very few electrons. In contrast to what is taught, electrons do not move independently in their own orbitals. Rather, they interact with each other such that their motions are correlated. Methods to address this 'electron correlation' problem are still being developed today. Sinanoğlu's early works represent an important step toward the goal of developing accurate approximations to the electronic Schrödinger equation. In addition, he introduced a successful solution to a problem of the topology of a Hilbert space and high symmetries it contains in quantum mechanics. Further, P. A. M. Dirac was also dealing with this problem but could not solve it. Sinanoğlu had thus built chemistry science on solid ground with this topologic solution. Another of his contributions is that he explained how the DNA helix retains its helix structure in solution (solvophobic theory).

Sinanoğlu was awarded many science awards for his outstanding works throughout his academic career. He received the TÜBİTAK Science Award, Alexander von Humboldt's Science Prize, and International Outstanding Scientist Award of Japan. In addition, he was nominated for a Nobel Prize in chemistry twice.

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Uğur Bozkaya

Abdurrahman Atalay

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"CARBON DIOXIDE SHOULD BE TAKEN FROM THE ATMOSPHERE AND STORED UNDERGROUND"

Prof Wally Broecker, the first person to warn the world about global warming, says CO_2 in the atmosphere must be captured and stored underground. This is the best way to keep global warming under control over the next 50 years, according to Broecker.

A lecturer at Columbia University, Broecker made this claim during his presentation at the International Carbon Conference in Iceland. The 150 scientists attending the conference discussed the removal of carbon from the atmosphere and its storage. In his presentation, Broecker said that the Earth had cooled very slowly over the past 51 million years, but that the rise in temperature caused by human activity would cause problems over the next 100,000 years. Broecker said, "We can't reduce our reliance of fossil fuels quickly enough, so we need to look at alternatives. One of the best ways to deal with this is likely to be carbon capture – in other words, putting the carbon back where it came from, underground. There has been great progress in capturing carbon from industrial processes, but to really make a difference we need to begin to capture atmospheric CO_2. Professor Eric Oelkers, one of the organizers of the conference, said, "We have proven methods to store carbon in the Earth but are limited in our ability to capture this carbon directly from the atmosphere. We are very good at capturing carbon from factories and power stations, but because roughly two-thirds of our carbon originates from disperse sources, implementing direct air capture is key to solving this global challenge.

Bilim ve Teknik (Science and Technology magazine), December 2019

İbrahim Özay Semerci

HOW DO TREES AFFECT THE TEMPERATURE OF CITIES?

The average temperature of areas with a high urbanization rate is 1-3 °C higher than that of rural areas around them. This difference can reach 12 °C at night. This phenomenon, which was first recorded by the British scientist Luke Howard in 1818, is called a heat island.

Some of the radiation that reaches the Earth from the sun is absorbed by the atmosphere, some of it is reflected back into space directly by the atmosphere, and the rest is absorbed by the surface of the Earth. The Earth's surface loses heat by radiation, convection, and evaporation. The balance between the energy the Earth receives and gives constitutes its energy "budget".

The main reason why the average temperature of the cities is higher than that of the rural areas is thought to be the decrease in evaporation and cooling in the cities. In addition to cooling by evaporation, trees and other plants contribute to the cooling process by the shade they create.

For example, the temperature of an object in the shade may be 11 °C to 25 °C lower than when exposed directly to the sun under the same conditions. The leaves and branches of trees and other plants allow only 10-30% of the energy from the sun to pass to the lower parts in the summer. This effect causes objects under trees to absorb the sun's rays less and their temperature rises less.

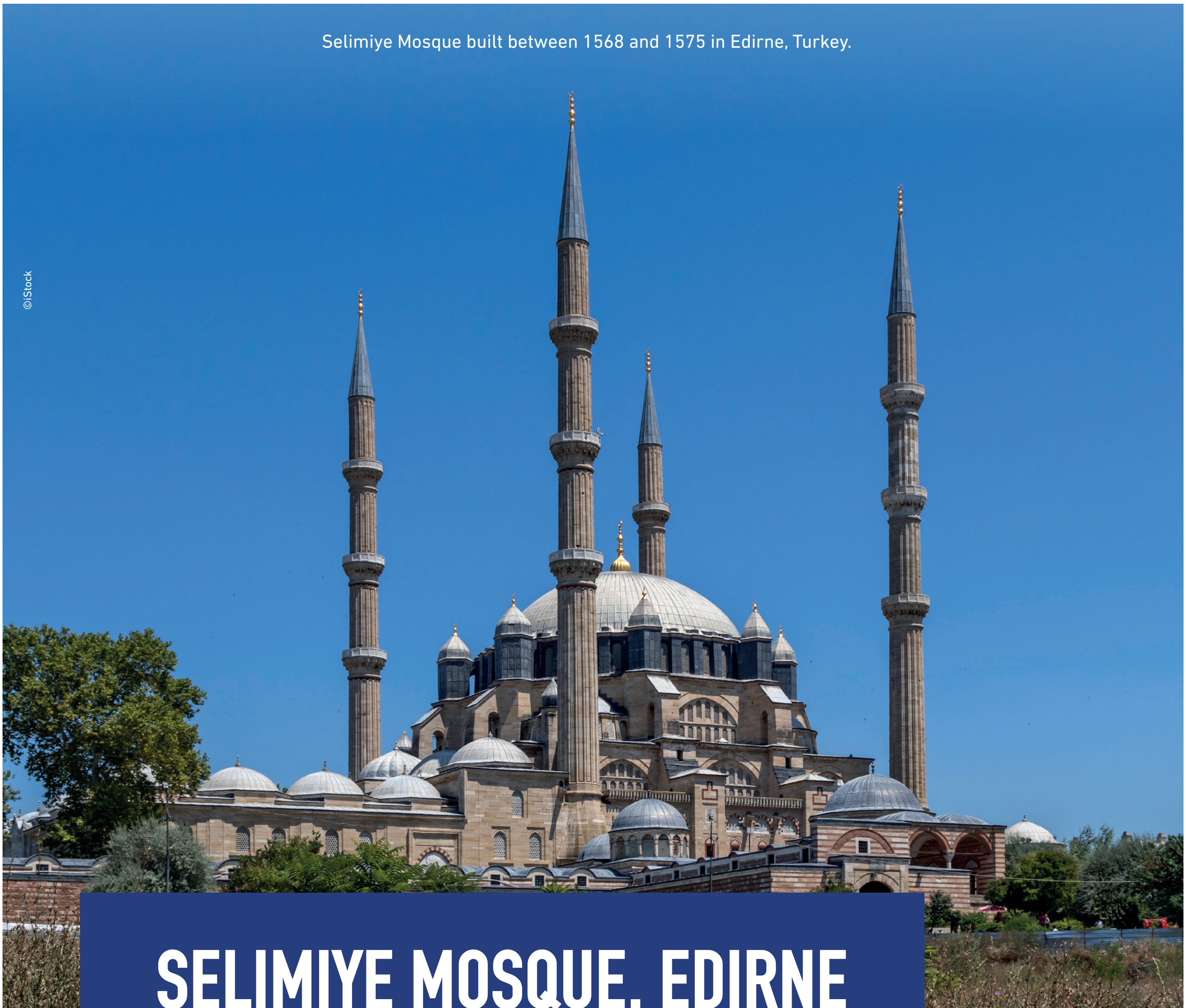
Trees and other plants also contribute to cooling by evaporation. Plants that convert water and carbon dioxide into food through photosynthesis take the water in the soil through their roots. They release some of the water they take from the soil through their leaves and stems through transpiration and dripping. In order for it to evaporate from liquid state to gas, water must take heat from outside. Therefore, evaporation helps to reduce the air temperature. Moisture in the soil also contributes to cooling by evaporation.

Research has shown that evaporation and shade can cause a drop in air temperature between 1 °C and 5 °C in summer.

Buildings and other unnatural structures and materials in cities absorb sunlight more than vegetation and soil do. Energy stored in these materials is released at night. This is one of the reasons why the temperature difference between urban and rural areas is higher at night. In addition, the high amount of heat released as a result of human activities in cities causes the energy exchange balance in cities to differ from that in rural areas. The type of materials used in the construction of buildings, the shape of buildings and streets, and human activities affect energy exchange in cities.

Bilim ve Teknik (Science and Technology magazine), April 2018

Tuba Sarıgül



Selimiye Mosque built between 1568 and 1575 in Edirne, Turkey.

SELIMIYE MOSQUE, EDIRNE

Hüseyin YURTTAŞ, Esra HALICI,
Burak Muhammet GÖKLER,
Muhammed Emin DOĞAN

Selimiye Mosque is the building that Sinan described as his masterpiece. It was built between 1568 and 1575 and is one of the best examples of Ottoman architecture. Selimiye Mosque, built as a complex on a hill, represents the highest level achieved by Ottoman architecture. The mosque was built using yellowish cut stone on a floor raised in the middle of a rectangular courtyard. It is covered with a single dome with a height of 42.25 m and a diameter of about 31.50 m that sits on eight supports. Thanks to this layout implemented by Mimar Sinan in the building, the congregation was gathered under a single dome.The balconies of the fluted minarets rising on polygonal bases

Cultural Heritages

Selimiye Mosque

at the four corners completing the mosque integrity are accessed by three separate stairways.

In addition to its architectural features, it is a very important example of Turkish-Islamic art with its stone, marble, tile, hand-drawn, and wooden decorations.

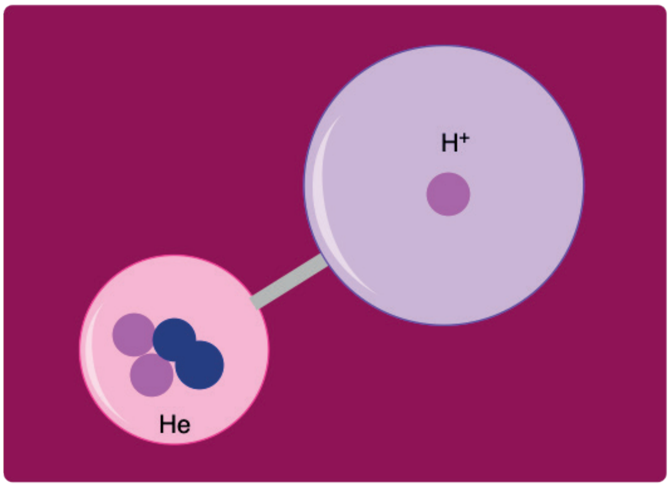
The platform for the muezzin, located in the middle of the sanctuary section, is supported by 12 marble columns.

The Iznik tiles decorating the building are one of the most beautiful examples of 16th century tile making and made by the glaze technique.

Selimiye Mosque and Complex in Edirne, which was the capital of the Ottoman Empire before Istanbul, was added to the UNESCO World Heritage List in 2011.

Selimiye Mosque

THE UNIVERSE'S FIRST MOLECULAR BOND: THE HELIUM HYDRIDE ION (HeH^+)



The helium hydride ion or hydrohelium (1+) cation, HeH^+, is a positively charged ion formed when a proton reacts with a gaseous helium atom. It was first discovered in 1925 and is isoelectronic with molecular hydrogen. It is the strongest acid known for its proton affinity (177.8 kJ/mol). This ion is also referred to as the helium hydride molecular ion. It has been suggested that it is found naturally in interstellar matter. It is the simplest heteronuclear ion and the hydrogen molecular ion is comparable to H_2^+. However, unlike H_2^+, there is permanent molecular polarization that facilitates spectroscopic characterization. Hydrogen and helium were the two first elements, and in the extreme conditions of the universe's birth astrochemists presumed they formed the first-ever molecular bond in HeH^+. Its first detection, in the nebula NGC 7027, was reported in an article published in the journal Nature in April 2019. Rolf Güsten, from the Max Planck Institute for Radioastronomy in Germany, and colleagues knew HeH^+ could exist; it was spotted in the lab in 1925. Güsten and colleagues observed the HeH^+ rotational ground state in a planetary nebula using a terahertz (THz) spectrometer flying on the airborne Stratospheric Observatory for Infrared Astronomy. Helium hydride may have no practical use here on Earth, but this most ancient of molecules is providing a fascinating insight into the way that the universe first evolved, and as such it is a compound with a compelling history.

$$He^+ + H \longrightarrow HeH^+ + h\nu$$

$$HeH^+ + e^- \longrightarrow He + H$$

$$HeH^+ + H \longrightarrow H_2^+ + He$$

Haydar Kılıç

TODAY'S PROBLEM AND YESTERDAY'S ANSWER

Problem 7.

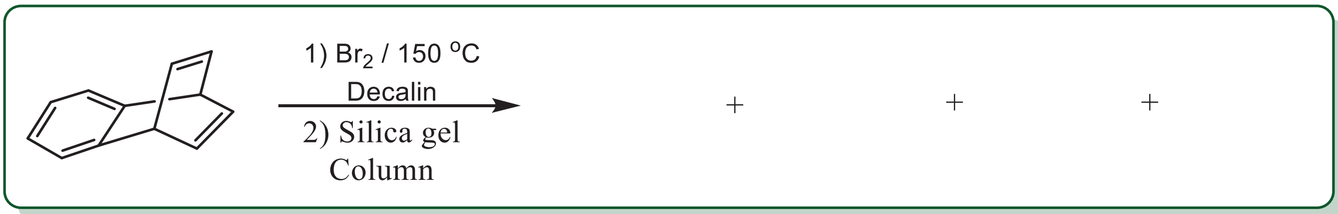
One reaction and many products

Both in the synthetic organic laboratory and in the chemical industry, one of the primary goals of modern chemistry is to control the identity and quantity of the products of chemical reactions. After the reaction, if the target compound is formed as a single product in quantitative yields, you are very lucky. However, this kind of reaction is very rare in organic synthesis. Sometimes the reactions surprisingly result in the formation of an abnormal number of products. In the literature, it has been reported that 18 products are formed under the reaction conditions given below. Estimate the structure of these products using the hints given.

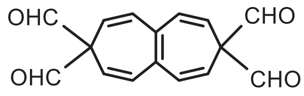
Arif Daştan

Hints:

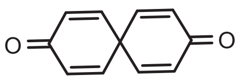
1) In addition to the ionic reaction, high-temperature bromination is known to be more predominantly radicalic.
2) Note that allylic and benzylic bromides can easily be hydrolyzed to related alcohols in the silica gel column.
3) Only one of the products is formed from the bromination of the solvent. This product has 3 signals in ^{13}C-NMR.



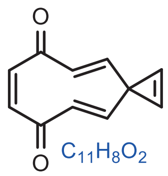
Solution: Problem 6



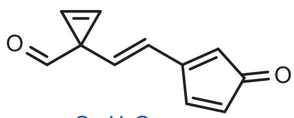
$C_{16}H_{12}O_4$



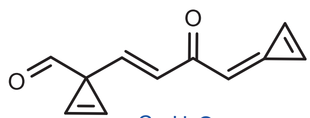
$C_{11}H_8O_2$



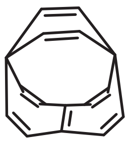
$C_{11}H_8O_2$



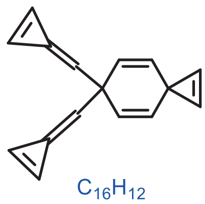
$C_{11}H_8O_2$



$C_{11}H_8O_2$



$C_{16}H_{12}$



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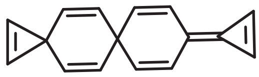

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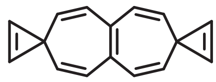
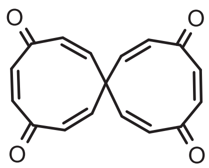
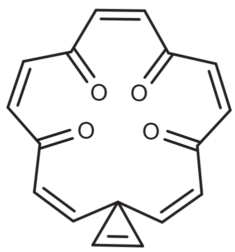


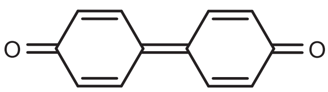
$C_{16}H_{12}$



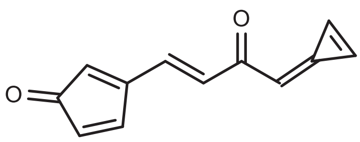
$C_{17}H_{12}O_4$



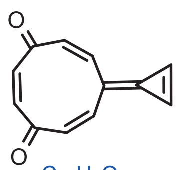
$C_{17}H_{12}O_4$



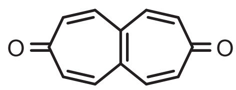
$C_{12}H_8O_2$



$C_{12}H_8O_2$



$C_{12}H_8O_2$



$C_{12}H_8O_2$

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