Philatelic 12s for G4G12

Michael Tanoff, Kalamazoo, MI
diandmi@sbcglobal.net
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In *Martin Gardner's Sixth Book of Mathematical Games from Scientific American* (W.H. Freeman and Company, 1971), Martin Gardner introduced his readers to Patrick O'Gara, the (fictitious) mathematical mailman. One of O'Gara's subcategories of his recreational mathematics passion was mathematical philately (stamp collecting), and he shared with Mr. Gardner some of the stamps from his collection, including a Greek postage stamp from 1955 illustrating the Pythagorean theorem, and stamps from a variety of countries like France, Russia, and Ireland honoring mathematicians such as Pascal, Laplace, Euler, Chebyshev, and Hamilton. Through O'Gara, Mr. Gardner introduced his readers to the concept of topical philately, and supplied several mathematical postage stamp references for readers who may have wanted to explore this area further. In honor of G4G12, the twelfth gathering in celebration of the life of Martin Gardner, and in Mr. Gardner's memory, this paper presents philatelic items — postage stamps, postmarks, postcards, etc. — of mathematical content related specifically to the number twelve.

Of course, the theme of twelve appears on any postage stamp whose illustration contains a standard analog clock. A fun example of this appears on a Swiss stamp from 2012 [**Figure 1**], on which a clock is "deconstructed" into its elements by Swiss comedian and "deconstruction artist" Ursus Wehrli.

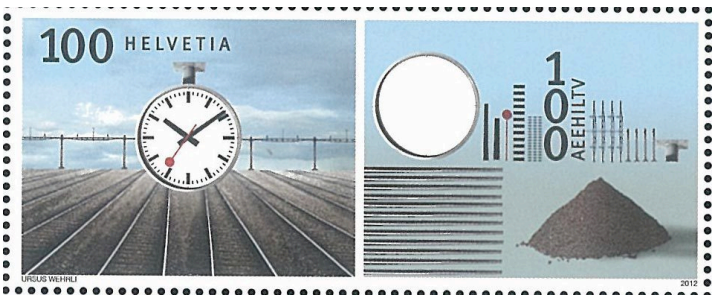

Figure 1
Clock on a Swiss stamp deconstructed into its basic elements, including its **12** *major (hour) tick marks*

The twelve tribes of Israel appear on several stamp issues by the Israeli government. Many countries have issued stamps featuring the twelve signs of the zodiac. The twelve atoms on a benzene molecule appear on German and East German stamps from 1964 and 1979, and a Belgian stamp from 1966 [**Figure 2**]. Regrettably, however, none of these examples of "12's" on stamps would be of particular interest to Patrick O'Gara. For "twelve" stamps with a more mathematical flavor, we turn to geometric figures, both two- and three-dimensional.

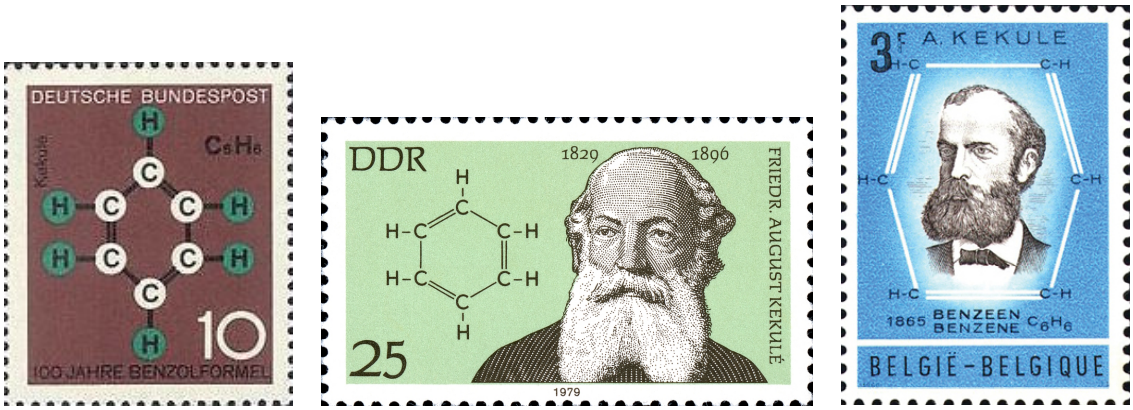

Figure 2

Three stamps illustrating the **<u>12</u>** *atoms in a benzene molecule*

The Chinese mathematician Liu Hui (c. 260 CE) determined upper and lower bounds for π by calculating the areas of concentric 96- and 192-gons. A page from his book, *Jiuzhang Suanshu*, *The Nine Chapters On the Mathematical Art*, appears on a Micronesia stamp from 1999 [**Figure 3**], part of a larger sheet of postage stamps celebrating the science and technology of ancient China during the first millennium. The page illustrates Liu Hui's method of approximating π using the regular dodecagon, the 12-sided regular polygon, as an example. A few hundred years later, Zhu Chongzhi (429–500 CE), also from China, bested Liu Hui's upper and lower bounds for π by approximating a circle with a $2^{13}\times 3$-sided regular polygon. His work, also at the stage of a 12-sided regular polygon, is illustrated on a 2015 stamp from Hong Kong [also **Figure 3**], part of a four-stamp set honoring ancient Chinese scientists.

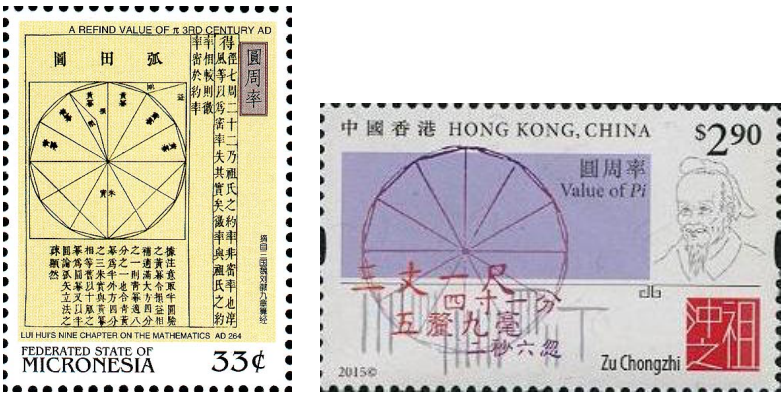

Figure 3

The **<u>12</u>***-sided regular dodecagon, used to approximate* π

Austrian composer and music theorist Josef Matthias Hauer developed a method of composing music using twelve equispaced pitches or tones. All possible combinations of these tones can be enumerated, graphically, using a dodecagon, as on the Austrian stamp from 1983, commemorating Hauer's 100th birthday [**Figure 4**].

Figure 4
The **12***-sided regular dodecagon*
used to illustrate all possible combinations
of **12** *equispaced musical pitches*

While the number of stamps featuring twelve-sided polygons is limited, the offerings increase when we turn to three dimensions and the Platonic (regular) solids (discussed by Martin Gardner in his second collection of "Mathematical Games" columns in *The 2nd Scientific American Book of Mathematical Puzzles & Diversions*, Simon and Schuster, 1961), which, all except for the tetrahedron, are rich in the number twelve!

We may begin with the **cube**, **which has twelve edges**. While many stamps feature cubes (or other twelve-edged rectangular solids), such as the 1970 Child Welfare stamp from the Netherlands [**Figure 5**], issued as part of a set of five cubes of different colors, a particularly entertaining cube is featured on the Austrian stamp from 1981 [also **Figure 5**], issued in honor of the 10th International Austrian Mathematical Congress held that year.

Figure 5
Cubes, whether real or impossible, have **12** *edges.*

Another special depiction of the cube appears on a Chinese postcard from 1990 [**Figure 6**] issued in honor of the 31st International Mathematical Olympiad, hosted by China that year. The illustration on the postcard demonstrates how one may bisect a cube to yield a face that is a regular hexagon. An East German first day cancellation from 1981 uses a cube to illustrate Euler's formula for non-self-intersecting polyhedra, faces + vertices – edges = 2 [**Figure 7**]. (More on that icosahedron, shortly.) A recently issued cube-on-stamp will

Figure 6
A demonstration of the **12***-edged cube revealing the regular hexagon*

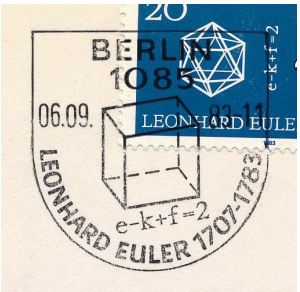

Figure 7
The **12** *edges of the cube*
support Euler's formula.

resonate with recreational mathematicians and mechanical puzzle enthusiasts, alike. "Europa" stamps are issued annually by participating European postal administrations, and have an agreed-upon common theme. The theme for 2015 was "old toys," and Lithuania's entry was a set of two burr puzzles, one of them being in the shape of a cube [**Figure 8**].

Figure 8
Composed of twenty-four sticks, this burr puzzle cube still has **12** *edges.*

The next regular solid is the **octahedron**, **which also has twelve edges**! The city of Nancy in France chose the octahedron as their symbol for the postmark advertising their hosting of the International Trade Fair and Exhibitions in 1968 [**Figure 9**], and Stockholm used the octahedron as a symbol in their commemorative postmark for the International Conference on Coordination Chemistry held in Stockholm in 1962 [also **Figure 9**].

Figure 9
*<u>**12**</u> edges on a regular solid? Not a cube, but an octahedron.*

A set of five stamps issued by Sweden in 2012 illustrate the space-tiling capabilities of the octahedron [**Figure 10**].

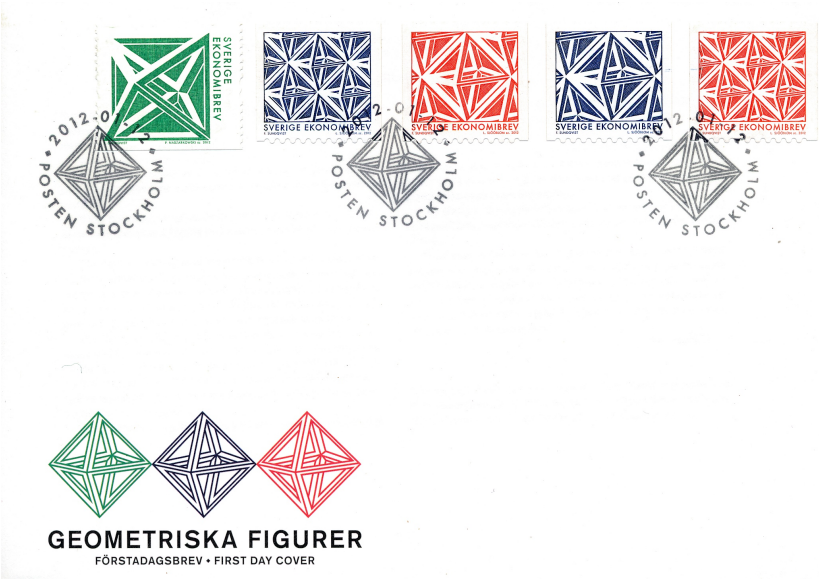

Figure 10
*The <u>**12**</u>-edged regular octahedron has space-tiling capabilities.*

Shifting our focus from edges to faces, the **dodecahedron**, the next Platonic solid, has **twelve faces**. To the ancient Greeks, the tetrahedron, cube, octahedron, and icosahedron represented the four basic elements of fire, earth, air, and water. The dodecahedron, however, was considered a representation of the entire universe, which could explain its prominent place in the Macau cosmology stamps from 2004 [**Figure 11**], part of Macau's ongoing annual "science and technology" series. (All five of the Platonic solids are pictured on the stamp on the mini-sheet of the same issue.) Most interestingly,

some modern cosmology theories are returning to the ancient Greeks' notion that the universe is dodecahedral in shape! (See, for example, Luminet, J.P., et al., "Dodecahedral space topology as an explanation for weak wide-angle temperature correlations in the cosmic microwave background," Nature 425 (6958):593–5, 2003.)

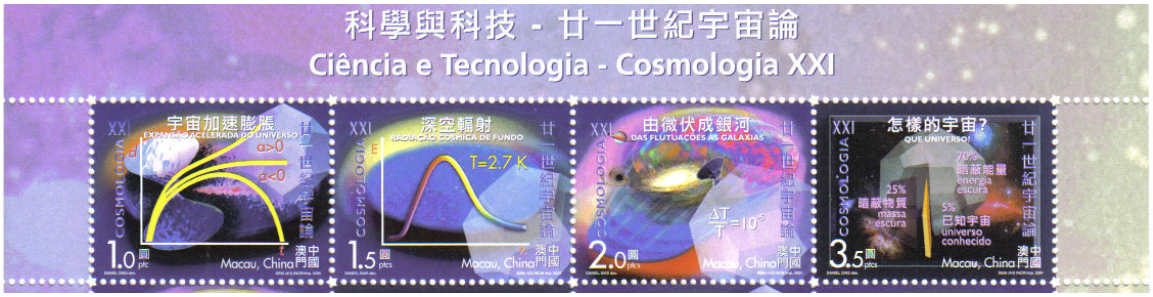

Figure 11
Does the universe exhibit the **12***-sided symmetry of the dodecahedron?*

For reasons unknown to this author, the Republic of China used the dodecahedron as the vehicle for celebrating the 40th anniversary of its Labor Insurance System, on a stamp issue from 1990 [**Figure 12**]. In 1964, Spain issued a series of fourteen stamps to commemorate twenty-five years of peace. The 1.50 peseta stamp focused on "modern" architecture that could be achieved during peacetime, and featured a dodecahedral building [also **Figure 12**]. And for much more purely mathematical reasons, the World Mathematical Year stamp from Monaco in 2000 prominently featured a dodecahedron among other symbols and figures associated with the golden ratio [also **Figure 12**].

Figure 12
Whether symbolic, applied, or purely mathematical,
dodecahedrons have **12** *faces.*

The dodecahedron has been used as a symbol to convey the study of fundamental properties of solids, such as when it was used in a Swedish commemorative cancellation for

the 1952 International Symposium on the Reactivity of Solids [**Figure 13**], or by France to commemorate the 3rd International Congress on Crystallography held at the Sorbonne in Paris in 1954 [also **Figure 13**]. And not surprisingly, the dodecahedron was used as the first day of issue postmark for the Macau cosmology set of stamps [also **Figure 13**], mentioned earlier.

Figure 13
*<u>**12**</u>-faced dodecahedrons used in a variety of philatelic applications*

Lastly, we turn to the **icosahedron**, which with its twenty faces and thirty edges has only **twelve vertices**. We caught a glimpse of an icosahedron in Figure 7, part of the illustration for an East German stamp from 1983, commemorating the 200th death anniversary of the great Swiss mathematician, Leonard Euler [**Figure 14**], and used as an example with which to demonstrate the aforementioned Euler's formula. The field of virology makes claim that arrangements of virus subunits are governed by icosahedral symmetry. Hence, the icosahedron was used a part of the design of a 1984 Japanese postage stamp issued in honor of the 6th International Virology Congress [also **Figure 14**].

Figure 14
*Whether in mathematical analysis or applied to the field of virology, the icosahedron's <u>**12**</u> vertices are significant.*

We may find another philatelic instance of the icosahedron being used to represent the field of virology, but for this, we need to look in the *selvage* of a sheet of German stamps issued in 2010 in honor of the 100th anniversary of the founding of the Friedrich Loeffler Institute, the National Institute of Animal Health in Germany [**Figure 15**]. (The stamp itself

illustrates some virus-like microbe.) Another example of an icosahedron appearing only in the selvage of a stamp issue is for the commemorative issued by Germany in 2008 honoring the 300th birthday of goldsmith and inventor of scientific instruments Wenzel Jamnitzer [also **Figure 15**]. The beautiful gold icosahedron on the corner selvage piece of the stamp sheet is just one of Jamnitzer's many works featuring the Platonic solids and their stellated counterparts.

Figure 15
Elusive philatelic icosahedrons and their **12** *vertices*
turn up in unexpected places, including a vertex!

Another "viral" philatelic example of the icosahedron is on the postage meter strip advertising the anti-viral drug Zovirax (generic name acyclovir, or aciclovir in Dutch) [**Figure 16**]. Lastly, borrowing a role from one of the dodecahedrons in Figure 13, the icosahedron was used in postmarks commemorating the 11th and 12th European Crystallographic Meetings in 1988 and 1989 in Vienna and Moscow [**Figure 17**].

Figure 16
The **12***-pointed virus structure*
in the face of the anti-viral drug

For any reader interested in further pursuits in mathematical philately, the author recommends that they consider membership in the Mathematical Study Unit of the American Topical Association. The study unit's web site is at ***www.mathstamps.org***. The unit's journal, *Philamath*, is published quarterly in January, April, July, and October.

Figure 17
The **12***-cornered icosahedron, like its dodecahedron cousin,*
has been used as a symbol for the study of fundamental properties of solids.

(Note: Stamps, postmarks, and other philatelic items appearing in the figures are not sized to relative scale.)

A far-from-comprehensive list of references on mathematical philately:

Gardner, M., *Martin Gardner's Sixth Book of Mathematical Games from Scientific American*, W.H. Freeman and Company, San Francisco, (1971) [Several references are provided at the end of Chapter 23, "O'Gara, the Mathematical Mailman."]

Miller, J., "Images of Mathematicians on Postage Stamps," http://jeff560.tripod.com/stamps.html

Schaaf, W.L., *Mathematics and Science: An Adventure In Postage Stamps*, National Council of Teachers of Mathematics, Virginia, (1978)

Wilson, R.J., *Stamping Through Mathematics*, Springer, New York, (2001)