

Dice

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Dice (singular **die** or **dice**;^[1] from French *dé*; from Latin *datum* "something which is given or played")^[2] are small throwable objects with multiple resting positions, used for generating random numbers. Dice are suitable as gambling devices for games like craps, and are also used in non-gambling tabletop games.

A traditional die is a rounded cube, with each of its six faces showing a different number of dots (pips) from 1 to 6. When thrown or rolled, the die comes to rest showing on its upper surface a random integer from one to six, each value being equally likely. A variety of similar devices are also described as dice; such specialized dice may have polyhedral or irregular shapes and may have faces marked with symbols instead of numbers. They may be used to produce results other than one through six. Loaded and crooked dice are designed to favor some results over others for purposes of cheating or amusement.



Four coloured dice showing all six possible sides

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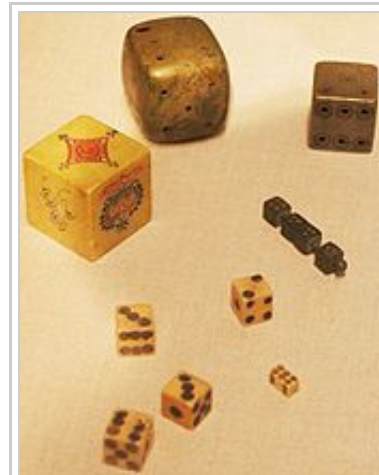
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History



Bone die found at Cantonment Clinch (1823–1834), an American fort used in the American Civil War by both Confederate and Union forces at separate times

Dice have been used since before recorded history, and it is uncertain where they originated. The oldest known dice were excavated as part of a 5000-year-old backgammon set at the Burnt City, an archeological site in south-eastern Iran.^[3] Other excavations from ancient tombs in the Indus Valley civilization indicate a South Asian origin.^[4] Dicing is mentioned as an Indian game in the *Rigveda*, *Atharvaveda* and Buddha games list.^[5] It also plays a critical role in the great Hindu epic *Mahabharata*, where Yudhishthira plays a game of dice against the



A collection of historical dice from various regions of Asia

Kauravas for the northern kingdom of Hastinapura, which becomes the trigger for a war.^[citation needed] There are several biblical references to "casting lots", as in Psalm 22, indicating that dicing (or a related activity) was commonplace when the psalm was composed. Knucklebones was a skill game played by women and children; a derivative form had the four sides of the bone receive different values and count as modern dice.^[citation needed] Gambling with two or three dice was a very popular form of amusement in Greece, especially with the upper classes, and a frequent accompaniment to symposia.^[citation needed]



Knucklebones die, made of steatite

Dice were originally made from the talus of hooved animals, colloquially known as "knucklebones". These are approximately tetrahedral, leading to the nickname "bones" for dice. Modern Mongolians still use such bones as shagai for games and fortunetelling.^[citation needed] Besides bone, materials like ivory, wood and plastics like cellulose acetate have been used. Dice are hard to distinguish from knucklebones in literature because ancient writers confused the two, but both were used in prehistoric times.^[citation needed]

The Romans were passionate gamblers, especially at the peak of the Roman Empire, and dicing was common though forbidden except during the Saturnalia. Horace derided youths who wasted time on dicing instead of horse-chasing. Throwing dice for money was the cause of many special laws in Rome, one of which stated that no lawsuit could be filed by a person who allowed gambling in his house, even if he had been cheated or assaulted.^[citation needed] Professional gamblers were common, and some of their loaded dice are preserved in museums. The public houses were the resorts of gamblers, and depictions of quarreling dicers can be seen on frescos.^[citation needed] Twenty-sided dice date back to the 2nd century AD^[6] and late BC.^[7]

Tacitus stated that the Germans were passionately fond of dicing, so much that they would stake their personal liberty when bankrupt.^[citation needed] During the Middle Ages, dicing became a favorite pastime of knights, who formed dicing schools and guilds.^[citation needed] After the downfall of feudalism, the landsknechts

established a reputation as the most notorious dicing gamblers of their time. In France, dice were used by both knights and ladies, despite repeated legislation against gambling with dice, including interdictions on the part of St. Louis in 1254 and 1256. The markings on Chinese dominoes evolved from the markings on dice.^[*citation needed*]

Usage

Dice are thrown onto a flat surface either from the hand or from a container designed for this (such as a dice cup). The face of the die that is uppermost when it comes to rest provides the value of the throw. One typical dice game today is craps, where two dice are thrown at a time and wagers are made on the total value of the two dice. Dice are frequently used to randomize moves in board games, usually by deciding the distance through which a piece will move along the board; examples of this are backgammon and *Monopoly*.

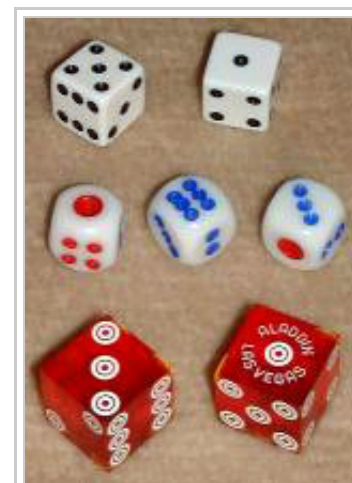
The result of a die roll is determined by the way it is thrown, according to the laws of classical mechanics. A die roll is made random by uncertainty in minor factors such as tiny movements in the thrower's hand; They are thus a crude form of hardware random number generator. Perhaps to militate against concerns that the pips on the faces of certain styles of dice cause a small bias,^[*citation needed*] casinos use precision dice with flush markings.

Construction

Arrangement

Common dice are small cubes most commonly 1.6 cm across,^[*citation needed*] whose faces are numbered from one to six, usually by patterns of round dots called pips. (While the use of Hindu-Arabic numerals is occasionally seen, such as in the game *Pop-O-Matic Trouble*, such dice are uncommon.) Opposite sides of a die traditionally add up to seven, implying that the 1, 2 and 3 faces share a vertex;^[8] these faces may be placed clockwise or counterclockwise about this vertex. If the 1, 2 and 3 faces run counterclockwise, the die is called "right-handed", and if those faces run clockwise, the die is called "left-handed". Western dice are normally right-handed, and Chinese dice are normally left-handed.^[9]

The pips on dice are arranged in specific patterns as shown. Asian style dice bear similar patterns to Western ones, but the pips are closer to the centre of the face; in addition, the pips are differently sized on Asian style dice, and the pips are coloured red on the 1 and 4 sides. One possible explanation is that red fours are of Indian origin.^{[9][10]} In some older sets, the "one" pip is a colorless depression.

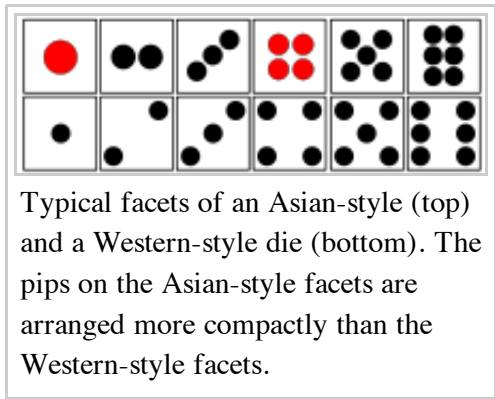


Western, Asian and casino dice

Manufacturing

Non-precision dice are manufactured via the plastic injection molding process. The pips or numbers on the dice are a part of the mold. The coloring for numbering is achieved by submerging the dice entirely in paint, which is allowed to dry, and then polished via a tumble finishing process similar to rock polishing. The abrasive agent scrapes off all of the paint except for the indents of the numbering. A finer abrasive is then used to polish the die. This process also creates the smoother, rounded edges on the dice.^[11]

Precision casino dice may have a polished or sand finish, making them transparent or translucent respectively. Casino dice have their pips drilled, then filled flush with a paint of the same density as the material used for the dice, such that the center of gravity of the dice is as close to the geometric center as possible. All such dice are stamped with a serial number to prevent potential cheaters from substituting a die.^[citation needed] Precision



backgammon dice are made the same way; they tend to be slightly smaller and have rounded corners and edges, to allow better movement inside the dice cup and

stop forceful rolls from damaging the playing surface.^[citation needed]

Terms

While the terms *ace*, *deuce*, *trey*, *cater*, *cinque* and *six* have been made obsolete by one to six, they are still used by some professional gamblers to designate different sides of the dice. *Ace* is from the Latin *as*, meaning "a unit";^[12] the others are 2 to 6 in old French.^[citation needed]

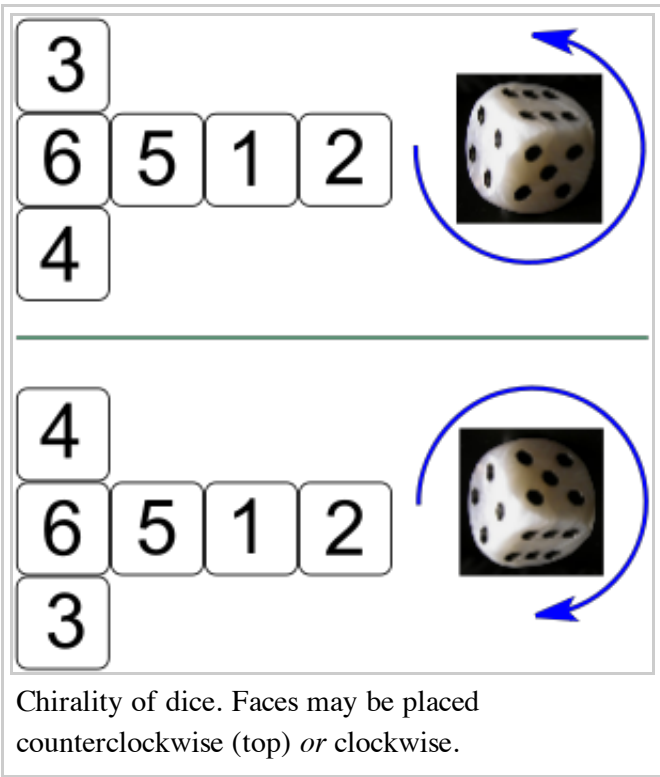
Notation

Main article: Dice notation

Using Unicode characters, the faces ☐ ▢ ▣ ▤ ▥ ▦, can be shown in text using the range U+2680–U+2685 or using decimal &9856;;–&9861;;.^[13]

In many gaming contexts, especially tabletop role-playing games, the count and number of sides of dice to be rolled at any given time is reduced to a common set of notations; typically these involve the letter "d" for dice. Hence, 6d8 means six eight-sided dice and 2d6 means two common dice. If an addition to the total rolled is needed, this is added to the end. 3d6+4 instructs the reader to roll three six-sided dice, calculate the total shown, and add four to it.^[citation needed]

Loaded dice



A loaded, weighted or crooked die is one that has been tampered with so that it will land with a specific side facing upwards more or less often than a fair die would. There are several methods for creating loaded dice, including round faces, off-square faces and weights. "Tappers" have a mercury drop in a reservoir at the center, with a capillary tube leading to another reservoir at a side; the load is activated by tapping the die so that the mercury travels to the side.^[*citation needed*]

Another type of loaded die is hollow with a small weight and a semi-solid substance inside whose melting point is just lower than the temperature of the human body, allowing the cheater to change the loading of the die by applying body heat, causing the semi-solid to melt and the weight to drift down, making the chosen opposite face more likely to land up.^[*citation needed*] A less common type of loaded die can be made by inserting a magnet into the die and embedding a coil of wire in the game table; running current through the coil increases the likelihood of a certain side landing on the bottom, depending on the direction of the current. Transparent acetate dice, used in all reputable casinos, are harder to tamper with than other dice.^[*citation needed*]

A die may be shaved on one side, making it slightly shorter in one dimension, thus affecting its outcome. One countermeasure employed by casinos against shaved dice is to measure the dice with a micrometer before playing.^[14]

Variants

Non-numeric

The faces of most dice are labelled using sequences of whole numbers, usually starting at one, expressed with either pips or digits. However, there are some applications that require results other than numbers. Examples include letters for Boggle, directions for *Warhammer Fantasy Battle*, playing card symbols for poker dice, and instructions for sexual acts using sex dice.

Non-cubic



A Platonic solids set of five dice

Seven- and eight-sided dice are described in the 13th century *Libro de los juegos* as having been invented by Alfonso X in order

to speed up play in chess variants.^{[15][16]} Around the end of 1960s, non-cubical dice became popular among players of wargames,^[17] and since have been employed extensively in role-playing games and trading card games. Reciprocally symmetric numerals like 6 and 9 are distinguished with a dot or underline.

The other four Platonic solids are the most common non-cubical dice; these can have 4, 8, 12, and 20 faces. The only other common non-cubical die is the 10-sided die. The 4-sided platonic solid is difficult to roll, and a few games like Dayakattai and Daldøs use a 4-sided rolling pin instead.^[*citation needed*] Using these dice in



10-sided dice are used in various games, often for generating percentages.

various ways, games can closely approximate the real probability distributions of the events they simulate. For instance, 10-sided dice can be rolled in pairs to produce a uniform distribution of random percentages; and summing the values of multiple dice will produce approximations to normal distributions.^[18]







Unlike other common dice, a tetrahedral die does not have a side that faces upward when it is at rest on a surface, so it has to be read in a different way. Many such dice have the numbers printed around the points, so that when it settles, the numbers at the vertex pointing up are the same and the one counted. Less commonly, the numbers on a tetrahedral die can be placed at the middle of the edges, in which case the numbers around the base are read.

A die can be constructed in the shape of a sphere, with the addition of an internal cavity in the shape of the dual polyhedron of the desired die shape and an internal weight. The weight will settle in one of the points of the internal cavity, causing it to settle with one of the numbers uppermost. For instance, a sphere with an octahedral cavity and a small internal weight will settle with one of the 6 points of the cavity held downwards by the weight.

Standard variations



Dice are often sold in sets, matching in color, of five or six different shapes (frequently also with a second 10-sided die of a complementary or contrasting color): the five Platonic solids, whose faces are regular polygons, and optionally the pentagonal trapezohedron, whose faces are ten kites, each with two different edge lengths and three different angles; the die's vertices also are of two different kinds.

Normally, the faces on a die will be numbered sequentially beginning with 1, and opposite faces will thus add up to one more than the number of faces (but in the case of the d4 and dice with an odd-number of faces, this is simply not possible). Some dice, such as d10, are usually numbered sequentially beginning with 0, in which case the opposite faces will add to one less than the number of faces.

Sides	Shape		Notes
4	tetrahedron		Each face has three numbers: they are arranged such that the upright number (which counts) is the same on all three visible faces. Alternatively, all of the sides have the same number in the lowest edge and no number on the top. This die does not roll well and thus it is usually thrown into the air instead.
6	cube		A common die. The sum of the numbers on opposite faces is seven.
8	octahedron		Each face is triangular; looks like two square pyramids attached base-to-base. Usually, the sum of the opposite faces is 9.
10	pentagonal trapezohedron		Each face is a kite. The die has two sharp corners, where five kites meet, and ten blunter corners, where three kites meet. The ten faces usually bear numbers from zero to nine, rather than one to ten (zero being read as "ten" in many applications). Often all odd numbered faces converge at one sharp corner, and the even ones at the other. The sum of the numbers on opposite faces is usually 9 (numbered 0–9) or 11 (number 1–10).
12	dodecahedron		Each face is a regular pentagon. The sum of the numbers on opposite faces is usually 13.
20	icosahedron		Faces are equilateral triangles. Icosahedrons have already been made in Roman/Ptolemaic times, but it is not known if they were used as gaming dice. Modern d20 are sometimes numbered 0–9 twice as an alternative to 10-sided dice. The sum of the numbers on opposite faces is 21 if numbered 1–20.

Rarer variations

Sides	Shape	Notes
1	sphere	Most commonly a joke die, ^{[<i>citation needed</i>]} this is just a sphere with a 1 marked on it. See also: non-cubical dice, Monostatic polytope, and Gömböc.
2	cylinder	This is nothing more than a coin shape with 1 marked on one side and 2 on the other. While some tasks in roleplaying require flipping a coin, the game rules usually simply call for the use of a coin rather than requiring the use of a two-sided die. It is possible, however, to find dice of this sort for purchase, but they are rare, and can typically be found among other joke dice.
3	Rounded-off triangular prism	This is a rounded-off triangular prism, intended to be rolled like a rolling-pin style die. The die is rounded-off at the edges to make it impossible for it to somehow land on the triangular sides, which makes it look a bit like a jewel. When the die is rolled, one edge (rather than a side) appears facing upwards. On either side of each edge the same number is printed (from 1 to 3). The numbers on either side of the up-facing edge are read as the result of the die roll. Another possible shape is the "American Football" or "Rugby ball" shape, where the ends are pointed (with rounded points) rather than just rounded. A third variety features faces that resemble warped squares.
5	Triangular prism	This is a prism that is thin enough to land either on its "edge" or "face". When landing on an edge, the result is displayed by digits (2–4) close to the prism's top edge. The triangular faces are labeled with the digits 1 and 5.

7	Pentagonal prism	Similar in constitution to the 5-sided die. When landing on an edge, the topmost edge has pips for 1–5. The pentagonal faces are labeled with the digits 6 and 7. This kind of die is particularly odd since it has pips for five of its results and digits for two of them. Seven-sided dice are used in a seven-player variant of backgammon. Some variants have heptagonal ends and rectangular faces.
12	rhombic dodecahedron	Each face is a rhombus.
14	heptagonal trapezohedron	Each face is a kite.
16	octagonal dipyrmaid	Each face is an isosceles triangle.
24	tetrakis hexahedron	Each face is an isosceles triangle.
24	deltoidal icositetrahedron	Each face is a kite.
30	rhombic triacontahedron	Each face is a rhombus. Although not included in most dice kits, it can be found in most hobby and game stores.
34	heptadecagonal trapezohedron	Each face is a kite. 
50	icosakaipentagonal trapezohedron	The faces of the 50-sided die are kites, although very narrow. 
60	pentakis dodecahedron	
60	Pentagonal hexecontahedron	Each face is a pentagon
100	Zocchihedron	100-sided dice can be found in hobby and game stores. They are made by flattening 100 facets on a sphere, but are not "uniform fair dice" as described below this table.

"Uniform fair dice" are dice where equal probability of the faces follow from the symmetry of the die as it is face-transitive), and include:

- Platonic solids, the five regular polyhedra: 4, 6, 8, 12, 20 sides
- Catalan solids, the duals of the 13 Archimedean solids: 12, 24, 30, 48, 60, 120 sides
- Bipyramids, the duals of the infinite set of prisms, with triangle faces: any even number above 4
- Trapezohedrons, the duals of the infinite set of antiprisms, with kite faces: any even number above 4
- Disphenoids, an infinite set of tetrahedra made from congruent non-regular triangles: 4 sides

Dice with an odd number of flat faces can be made as "rolling-pin style dice".^[19] They are based on an infinite set of prisms. All the (rectangular) faces they may actually land on are congruent, so they are equally fair. (The other 2 sides of the prism are rounded or capped with a pyramid, designed so that the die never actually rests on those faces.)

Probability

For a single roll of a fair s -sided die, the probability of rolling each value is exactly $\frac{1}{s}$; this is an example of a discrete uniform distribution. For n multiple rolls with an s -sided die, the possibility space is equal to s^n . So, for n rolls of an s -sided die, the probability of any result is $\frac{1}{s^n}$.

In the case of rolling two dice and adding the result together, as in the game of craps, the total is distributed in a triangular curve:

Sum	2	3	4	5	6	7	8	9	10	11	12
Probability	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$
		$=$	$=$	$=$		$=$		$=$	$=$	$=$	
		$\frac{1}{18}$	$\frac{1}{12}$	$\frac{1}{9}$		$\frac{1}{6}$		$\frac{1}{9}$	$\frac{1}{12}$	$\frac{1}{18}$	

As the number of dice increases, the distribution of the sum of all numbers tends to normal distribution by the central limit theorem; the exact value $F_{s,n}(k)$ of a sum of n s -sided dice, k , is

$$F_{s,n}(k) = \sum_{i=1}^{k-n+1} F_{s,1}(i) F_{s,n-1}(k-i)$$

where $F_{s,1}(k) = 1/s$ for $1 \leq k \leq s$ and 0 otherwise.

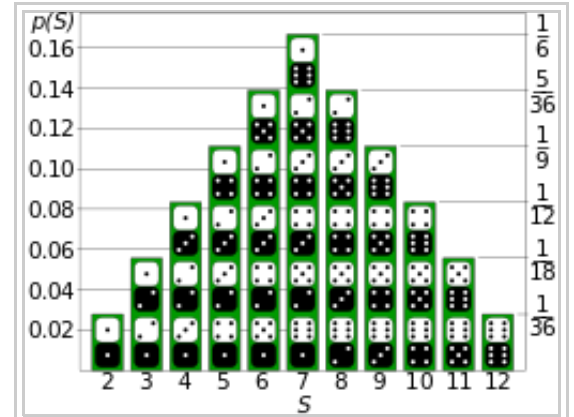
A faster algorithm would adapt the exponentiation by squaring algorithm:

$$F_{s,x+y}(k) = \sum_i F_{s,x}(i) F_{s,y}(k-i).$$

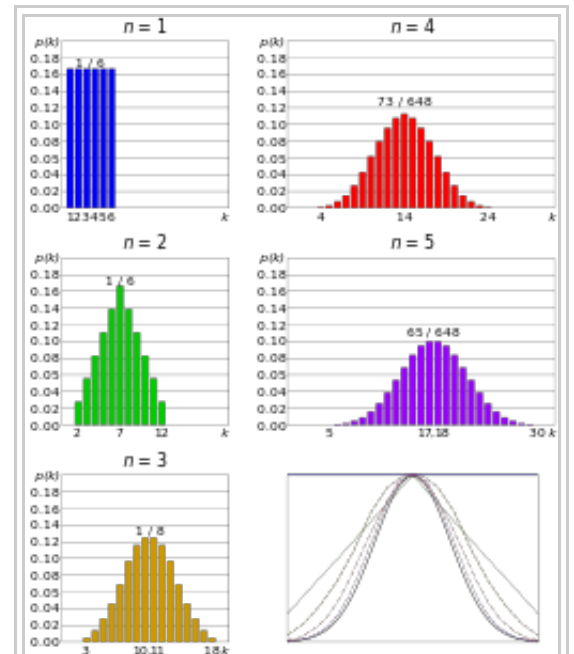
In the triangular curve described above,

$$\begin{aligned} F_{6,2}(6) &= \sum_n F_{6,1}(n) F_{6,1}(6-n) \\ &= F_{6,1}(1) F_{6,1}(5) + F_{6,1}(2) F_{6,1}(4) + \\ &\quad \cdots + F_{6,1}(5) F_{6,1}(1) \\ &= 5 \cdot \frac{1}{6} \cdot \frac{1}{6} = \frac{5}{36} \approx 0.14 \end{aligned}$$

Equivalently, the probability can be calculated using combinations:



Probability density function, $p(S)$, for the sum of two fair six-sided dice, S .



Comparison of probability density functions, $p(k)$ for the sum of n fair 6-sided dice to show their convergence to a normal distribution with increasing n , in accordance to the central limit theorem. In the bottom-right graph, smoothed profiles of the previous graphs are rescaled, superimposed and compared with a normal distribution (black curve).

$$F_{s,n}(k) = \frac{1}{s^n} \sum_{i=0}^{\lfloor \frac{k-n}{s} \rfloor} (-1)^i \binom{n}{i} \binom{k-si-1}{n-1}$$

where $\lfloor x \rfloor$ is the floor function. As before, the probability of rolling an exact sequence of numbers is $\frac{1}{s^n}$.

Application in role-playing games

The fantasy role-playing game *Dungeons & Dragons* (D&D) is largely credited with popularizing dice in such games. Some games use only one type, like *Exalted* which uses only ten-sided dice. Others use numerous types for different game purposes, such as D&D, which makes use of all common polyhedral dice.

Dice are used to determine the outcome of events; such usage is called a *check*. Games typically determine results either as a total on one or more dice above or below a fixed number, or a certain number of rolls above a certain number on one or more dice. Due to circumstances or character skill, the initial roll may have a number added to or subtracted from the final result, or have the player roll extra or fewer dice. To keep track of rolls easily, dice notation is frequently used.

A common special case is percentile rolls, referred to as 1d100 or 1d%. Since actual hundred-sided dice are large, almost spherical, and difficult to read, percentile rolls are instead handled by rolling two ten-sided dice together, using one as the "tens" and the other as the "units". A roll of ten or zero on either die is taken as a zero, unless both are zeros or tens, in which case this is 100. Some sets of percentile dice explicitly mark one die in tens and the other in units to avoid ambiguity.

Dice for role-playing games are usually plastic; early polyhedral dice from the 1970s and 1980s were made of a soft plastic that would easily wear as the die was used, and wear would gradually render the die unusable. Many early dice were unmarked, and players took great care in painting them. Some twenty-sided dice then were numbered zero through nine twice; half of the numbers had to be painted a contrasting color to differentiate faces. These could double as a ten-sided die by ignoring the distinguishing coloring.

Application in divination

Dice can be used for divination; using dice for such a purpose is called cleromancy. A pair of common dice is usual, though other forms of polyhedra can be used. Tibetan Buddhists sometimes use this method of divination. It is highly likely that the Pythagoreans used the Platonic solids as dice; they referred to such dice as "the dice of the gods" and they sought to understand the universe through an understanding of geometry in polyhedra.^[20]



Typical role-playing dice, showing a variety of colors and styles. Note the older hand-inked green 12-sided die (showing an 11), manufactured before pre-inked dice were common. Many players collect or acquire a large number of mixed and unmatching dice.

Astrological dice are a specialized set of three 12-sided dice for divination; the first die represents planets, the Sun, the Moon, and the nodes of the Moon; the second die represents the 12 zodiac signs; and the third die represents the 12 houses. An icosahedron provides the answers of the Magic 8-Ball, conventionally used to provide answers to yes-or-no questions.

See also

- Barrel die
- Crown and Anchor
- d20 system
- Dreidel
- Fudge dice
- Fuzzy dice
- Musikalisches Würfelspiel*
- Nontransitive dice
- Sicherman dice
- Teetotum
- Urim and Thummim



Medieval People at Play. The Walters Art Museum, Baltimore

Notes

- ↑ Definition of dice in English (<http://oxforddictionaries.com/definition/english/dice>), Oxford Dictionaries
- ↑ "die" (http://www.askoxford.com/concise_oed/die_2?view=uk). AskOxford. Retrieved 2012-06-18.
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- ↑ Possehl, Gregory. "Meluhha". In: J. Reade (ed.) *The Indian Ocean in Antiquity*. London: Kegan Paul Intl. 1996a, 133–208
- ↑ 2.3, 4.38, 6.118, 7.52, 7.109
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- ↑ "metmuseum.org (Dice)" (<http://www.metmuseum.org/collections/search-the-collections?what=Dice>). metmuseum.org. Retrieved 2012-11-06.
- ↑ Cf. *Greek Anthology* (<http://www.archive.org/details/greekanthology05newyuoft>) Book 14, §8: "The Opposite Pairs of Numbers on a Die. The numbers on a die run so: six one, five two, three four."
- ↑ ^{*a*} ^{*b*} Standard Dice (<http://homepage.ntlworld.com/dice-play/DiceStandard.htm>) from dice-play
- ↑ Chinese Dice (<http://www.gamesmuseum.uwaterloo.ca/Archives/Culin/Dice1893/dice.html>) from the Elliott Avedon Museum & Archive of Games
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- ↑ Jon Peterson (July 2012). *Playing at the World: A History of Simulating Wars, People and Fantastic Adventures, from Chess to Role-Playing Games*. Unreason Press. pp. 315–318. ISBN 978-0-615-64204-8.
- ↑ Michelle Paret and Eston Martz (2009). "Tumbling Dice & Birthdays: Understanding the Central Limit Theorem"

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19. ^ "Properties of Dice" (<http://www.aleakybos.ch/Properties%20of%20Dice.pdf>). <http://www.aleakybos.ch>. Retrieved 2012-10-07.
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External links

- Weisstein, Eric W., "Dice (<http://mathworld.wolfram.com/Dice.html>)", *MathWorld*. Analysis of dice probabilities, also features Uspenski's work on rolling multiple dice.
- Mathematically "Fair Dice"
 - "Fair Dice" (http://www.maa.org/editorial/mathgames/mathgames_05_16_05.html) is an illustrated *Math Games* (<http://www.maa.org/news/mathgames.html>) column about all the possible fair dice, and the mathematical reasons why other shapes are not fair.
 - A complete list of all possible Fair Dice (<http://www.mathpuzzle.com/Fairdice.htm>) which has nice illustrations
- Animation (<http://www.youtube.com/watch?v=9eaOxgT5ys0>) clearly demonstrating the probability space of dice
- World's Largest Dice Collection (<http://www.dicecollector.com/>) Links, Photos, Information about dice
- Computer Simulation of Irregular Dice (<http://www.physics.ox.ac.uk/cm/cmt/cuboid>)
- "A Pair of Dice Which Never Roll 7" (<http://www.chiark.greenend.org.uk/~sgtatham/dice/>)
- The oldest backgammon set found in Iran (http://www.gamblinggates.com/news/gaming/oldest_backgammon_set31041.html)
- "A Brief History of Dice" (<http://www.wizards.com/default.asp?x=dnd/alumni/20070302a>) (in *Dungeons & Dragons* games)
- "How do you make loaded dice?" (<http://www.straightdope.com/columns/read/2878/how-do-you-load-a-pair-of-dice>), *The Straight Dope*, July 14, 2009
- A discussion linking dice and Tarot cards (<http://www.cs.utk.edu/~mclennan/BA/PT/Mintro.html>)
- "Why Dice Behave the Way They Do" (<http://books.google.com/books?id=PiEDAAAAMBAJ&lpg=PA128&dq=popular%20science%20july%201945&pg=PA120#v=onepage&q&f=true>), *Popular Science* July 1945
- Dice size chart (<http://www.dicegamedepot.com/dice-sizes/>) shows common dice dimensions
- "Dice – A Dicey Love Affair" (<http://www.boardgamegeek.com/geeklist/37741/dice-a-dicey-love-affair>) A list of board games with special dice

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