IJTMIR

e-ISSN: Applied

International Journal of Technology, Management & Inter-disciplinary Research (IJTMIR)

(Peer-Reviewed, Open Access, Fully Refereed International Journal)

Volume:01/Issue:01/November-2025

New Value of pi π (17 - 8√3) using the area of circle

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ABSTRACT

The paper aims to show that (π) has an exact value 17-8√3. The derivation of this value is supported by several geometrical constructions, arithmetic calculations and use of some simple algebraic formulae. There are various values of π that have been discussed in ancient literature. Vedic texts hinted at π, and Aryabhata's 3.1416 was among the most precise in antiquity. Early cultures often used whole-number ratios for convenience in construction, ritual or symbolic texts weren't focused on mathematical precision. This paper deals with the new value of π and can be proved using the geometric constructions and algebraic formulas.

Keywords: pi value,

1. Introduction

Determination of the ratio of circumference of circle with its diameter has been a problem of much more interest in the field of mathematics for thousands of years. The ratio of circumference of circle/diameter is denoted by a Greek letter π. It is believed that the constant (π) is a transcendental number. Its value has been computed correctly up to several trillions of digits. For practical purposes, the value of pi is taken approximately equal to 22/7, 355/113 etc. However, mathematicians of the world suffer a serious drawback in finding the value of π, while using the methods like use of infinite series, trigonometry, division of area of circle into infinite symmetric parts n sided polygon and many others, where one cannot measure the end point quantities exactly. This causes an obvious limitation on obtaining exact value of π. The sections which follow, describe the exact value of π is 17-8√3 and the derivation to obtain it [1-13].

Basic information:

Note: let a, b, c & d, each part shows their areas in following figures

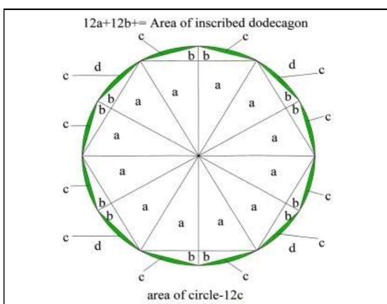

Figure 1

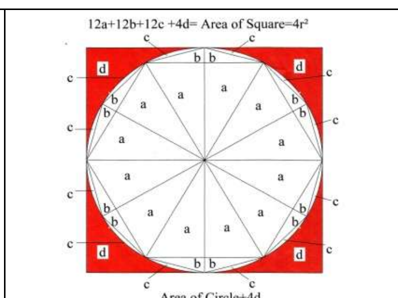

Figure 2

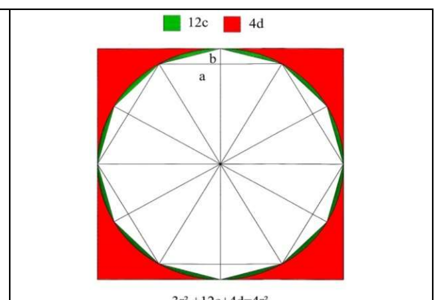

Figure 3

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Area of inscribed dodecagon = (12a + 12b) = $3r^2$ = (πr^2 - 12c)	Area of circumscribed square = (12a + 12b + 12c + 4d) = $4r^2$ = (πr^2 + 4d)	$(4 - \pi)\, r^2 = 4d$ $(\pi - 3)\, r^2 = 12c$ $(4d + 12c) = [(4 - \pi) + (\pi - 3)] = 1$

Figure 1: Shows the area of inscribed dodecagon
Figure 2: shows the area of circumscribed square
Figure 3: Indicates both, areas of inscribed dodecagon and circumscribed square

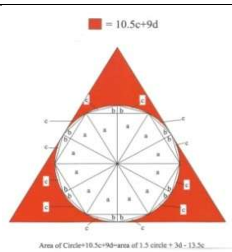
Area of inscribed hexagon = 12a = $(1.5\sqrt{3})\, r^2$ a = $(0.125\sqrt{3})\, r^2$
Area of inscribed dodecagon = (12a + 12b) = $3r^2$ = (πr^2 – 12c) (12a + 12b) – 12a
= 12b = $(3 - 1.5\sqrt{3})\, r^2$ b = $(0.25 - 0.125\sqrt{3})\, r^2$

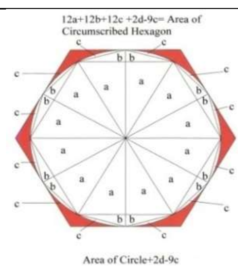
Area of circumscribed square = (12a + 12b + 12c + 4d) = $4r^2$= (πr^2 + 4d)
Area of circle = (12a + 12b + 12c) = ($3r^2$ + 12c) = ($4r^2$ - 4d) (12c + 4d = $1r^2$)/4 = (3c + d = $0.25r^2$ = a + b)

As it is known that the exact area of inscribed dodecagon = $3r^2$. To calculate exact area of circle, we must calculate exact area of 12c. Hence, there is no need to divide whole circle into infinite number of parts to calculate its accurate area. Now the question arises to how to estimate the exact area of part 12c & part 4d?

From above information:
(Area of circle – 12c) = area of inscribed dodecagon = $3r^2$
(Area of circle – 9c) = (area of 0.75 inscribed dodecagon + area of 0.25 circles)
(Area of circle – 6c) = (area of 0.5 inscribed dodecagon + area of 0.5 circles)
(Area of circle – 3c) = (area of 0.25 inscribed dodecagon + area of 0.75 circles)

(Area of circle + 4d) = Area of circumscribed square = $4r^2$
(Area of circle + 3d) = (Area of 0.75 circumscribed square + area of 0.25 circles)
(Area of circle + 2d) = (Area of 0.5 circumscribed square + area of 0.5 circles)
(Area of circle + d) = (Area of 0.25 circumscribed square + area of 0.75 circles)





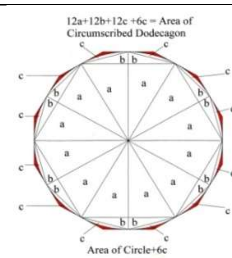


Figure 4	Figure 5	Figure 6
Area of circumscribed triangle = $(3\sqrt{3})\, r^2$ = (24a) = (area of circle + 9d + 10.5c)	Area of circumscribed hexagon = $(2\sqrt{3})\, r^2$ = (16a) = (area of circle + 2d – 9c)	Area of circumscribed dodecagon = $12(2 - \sqrt{3})\, r^2$ = (96b) = (area of circle + 6c)

Figure 4: Shows the area of circumscribed triangle
Figure 5: Shows the area of circumscribed hexagon
Figure 6: Shows the area of circumscribed dodecagon

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Proof of above equations

[Area of circumscribed (4 triangle + 12 hexagon + 3 dodecagon)]

Value	equations
[Area of circumscribed (4 triangle + 12 hexagon + 3 dodecagon)] $= 4(3\sqrt{3})\ r^2 + 12(2\sqrt{3})\ r^2 + 3(24 - 12\sqrt{3})\ r^2$ $= (12\sqrt{3})\ r^2 + (24\sqrt{3})\ r^2 + (72 - 36\sqrt{3})\ r^2$ $= 72r^2$	[Area of circumscribed (4 triangle + 12 hexagon + 3 dodecagon)] = [area of 4(circle + 9d + 10.5c) + area of 12(circle + 2d – 9c) + area of 3(circle + 6c)] = [area of (4 + 12 + 3) circle + (36d + 42c) + (24d – 108c) + 18c] = area of 19 circle + (60d – 48c) = area of [15(circle + 4d) + 4(circle – 12c)] = [area of 15 circumscribed square $= 15(4r^2)$ + area of 4 inscribed dodecagon] $= 4(3r^2)$ $= (60 + 12)\ r^2 = 72r^2$

One more example:

Area of circumscribed (2 hexagons + 3 dodecagons)

Value	equations
Area of circumscribed (2 hexagon + 3 dodecagon) $= 2(2\sqrt{3})\ r^2 + 3(24 - 12\sqrt{3})\ r^2$ $= (4\sqrt{3})\ r^2 + (72 - 36\sqrt{3})\ r^2$ $= (72 - 32\sqrt{3})\ r^2$	Area of circumscribed (2 hexagon + 3 dodecagon) = area of (2 + 3) circle + 2(2d – 9c) + 3(6c) = area of 5 circle + (4d – 18c + 18c) = area of 5 circle + 4d = area of 4 + (1circle + 4d) = area of 4 circle + area of 1 circumscribed square Area of 4 circle $= (72 - 32\sqrt{3})\ r^2$ - area of circumscribed square $= [(72 - 32\sqrt{3})\ r^2 - 4r^2]$ $= (68 - 32\sqrt{3})\ r^2$ Area of circle $= (68 - 32\sqrt{3})\ r^2/4$ $= (17 - 8\sqrt{3})\ r^2$

Algebraic method

Note x, is any number

Area of circumscribed (x hexagon + x dodecagon)

= area of (x + x) circle + x [(2d – 9c) + 6c]

= area of 2x circle + [x (2d – 3c) ....step 1

Area of 2x circle + x (2d)

= area of x [0.5 square + (2 – 0.5 = 1.5 circle)] .... step 2

Area of x (1.5 circle – 3c)

= area of x [0.25 inscribed dodecagon + (1.5 – 0.25 = 1.25 circle)] ....step 3

Adding step 2 and step 3

= [area of (0.5x) square + area of (0.25x) inscribed dodecagon + area of 1.25x circle]

From above information:

Area of circumscribed (x hexagon + x dodecagon)
= [area of (0.5x) square + area of (0.25x) inscribed dodecagon + area of (1.25x) circle]
= area of x [$0.5(4r^2) + 0.25(3r^2) + 1.25(17 - 8\sqrt{3})\, r^2$]

For example x = 32
Area of circumscribed (32 hexagons + 32 dodecagons)
$= 32(2\sqrt{3})\, r^2 + 32[12(2 - \sqrt{3})]\, r^2$
$= (64\sqrt{3})\, r^2 + (768 - 384\sqrt{3})]\, r^2$
$= (768 - 320\sqrt{3})]\, r^2$
= Area of [32(0.5) = 16 square + 32(0.25) = 8 inscribed dodecagon + 32(1.25) = 40 circle]
Area of 40 circle = $(768 - 320\sqrt{3})]\, r^2$ – area of (16 circumscribed square + 8 inscribed dodecagon)
$= (768 - 320\sqrt{3})]\, r^2 - \{16(4r^2) + 8(3r^2)\}$
$= (768 - 320\sqrt{3})]\, r^2 - (64r^2 + 24r^2)$
$= (680 - 320\sqrt{3})]\, r^2$
Area of circle $= (680 - 320\sqrt{3})]\, r^2 /40$
$= (17 - 8\sqrt{3})]\, r^2$
Many more examples of this type are solved to get appropriate answers in every example.
Note x, is any number
Area of x inscribed dodecagon + area of circumscribed x (triangle + hexagon + dodecagon)
= area of x (circle – 12c) + area of x (circle + 9d + 10.5c) + x (circle + 2d – 9c) + x (circle + 6c)
= area of 4x circle + x [- 12c + (9d + 10.5c) + (2d – 9c) + 6c]
= area of 4x circle + x (11d – 4.5c)………step 1
Area of 4x circle + x (11d) = x (2.75 circle + 11d = 2.75 circumscribed square) (11d/4d = 2.75) ………..step 2
Area of (4x – 2.75x) = 1.25x circle
Area of x [1.25 circles – 4.5c = (0.375 inscribed dodecagon + (1.25 – 0.375) 0.875 circle]
(4.5c/12c = 0.375)………step 3

Adding step 2 and step 3
= Area of x inscribed dodecagon + area of circumscribed x (triangle + hexagon + dodecagon)
= area of (2.75x circumscribed square + 0.375x circumscribed dodecagon + 0.875x circle)
= area of x [$2.75(4r^2) + 0.375(3r^2) + 0.875(17 - 8\sqrt{3})\, r^2$]

For example: x = 8
{Area of 8 inscribed dodecagons + [area of circumscribed (8 triangles + 8 hexagons + 8 dodecagons)]}
$= 8(3r^2) + 8(3\sqrt{3})\, r^2 + 8(2\sqrt{3})\, r^2 + 8(24 - 12\sqrt{3})\, r^2$
$= (24r^2) + (24\sqrt{3})\, r^2 + (16\sqrt{3})\, r^2 + (192 - 96\sqrt{3})\, r^2$
$= (216 - 56\sqrt{3})\, r^2$
= area of 8(2.75 circumscribed square + 0.375 inscribed dodecagon + 0.875 circle)
= area of (22 circumscribed square + 3 inscribed dodecagon + 7 circle)
Area of 7 circle = $(216 - 56\sqrt{3})\, r^2$ - area of (22 circumscribed square + 3 inscribed dodecagon)
$= (216 - 56\sqrt{3})\, r^2$ - area of $[22(4r^2) + 3(3r^2)]$
$= (216 - 56\sqrt{3})\, r^2 - [(88r^2) + (9r^2)]$
$= (216 - 56\sqrt{3})\, r^2 - (97r^2)$
$= (119 - 56\sqrt{3})\, r^2$

Area of circle = $(119 - 56\sqrt{3})\, r^2/ 7$
= $(17 - 8\sqrt{3})\, r^2$

Many examples of this type have been solved to get appropriate answers.

Conclusions:

Exact Area of circle = $(17 - 8\sqrt{3})\, r^2$. This paper claims to have found out the exact value of π has been found to be $(17 - 8\sqrt{3})$ and is shown algebraically as well as geometrically.

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