FAU MATH DAY 2011
Math Trivia Challenge

MATHEMATICAL DIVERSIONS 2011

Warm up Question

- The ratio of the circumference of a circle to its diameter

A. is known to be infinite.
B. is denoted by the Greek letter π (pi).
C. depends on the particular circle.
D. depends on the day of the week.
E. is one of the seven wonders of the ancient world.

Warm up Question

Do you like pie?

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B. is denoted by the Greek letter π (pi).

C. depends on the particular circle.

D. depends on the day of the week.

E. is one of the seven wonders of the ancient world.

- Usually there will be a third slide with some explanation of the answer. Or I'll give one.
- I can't help myself from adding such a page!
- **Format from now on**: Math questions and so called trivia will alternate. You'll have one minute to answer "trivia", one to three minutes for the math.

The Babylonians

- The Babylonians wrote numbers in base 60. One of their tablets states that the ratio of a regular hexagon to the circumference of the circumscribed circle is $\frac{57}{60}+\frac{36}{3600}$

- This means that for them π was equal to

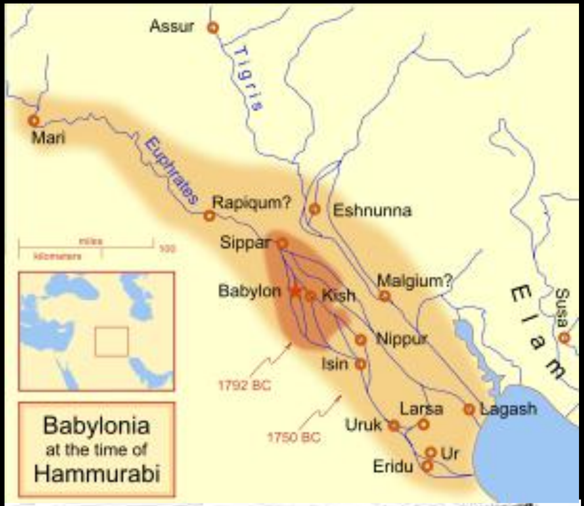
A. 3.00

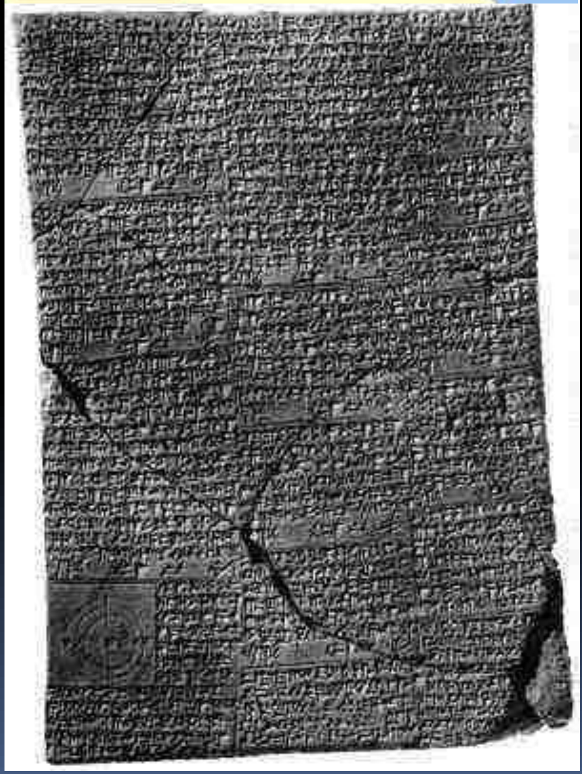
B. 3.125

C. 3.14

D. 3.22

E. 3.25





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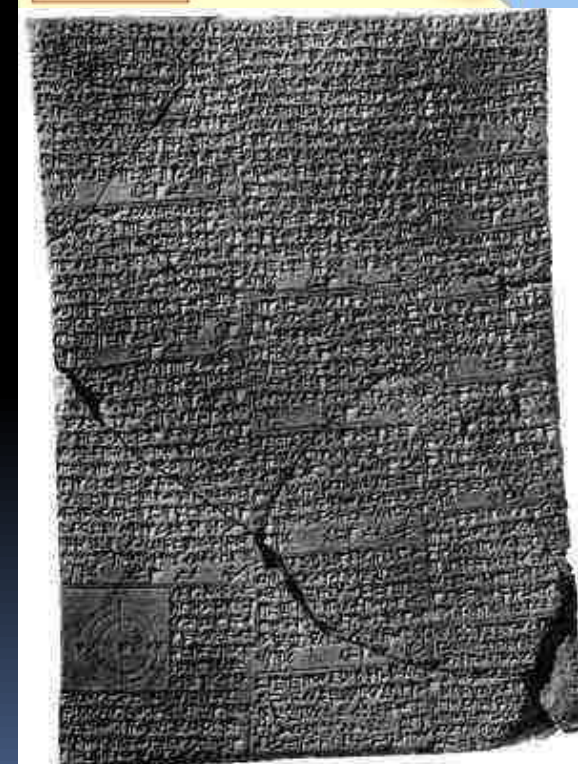

The Babylonians

- The Babylonians wrote numbers in base 6o. One of their tablets states that the ratio of a regular hexagon to the circumference of the circumscribed circle is $\frac{57}{60} + \frac{36}{3600}$

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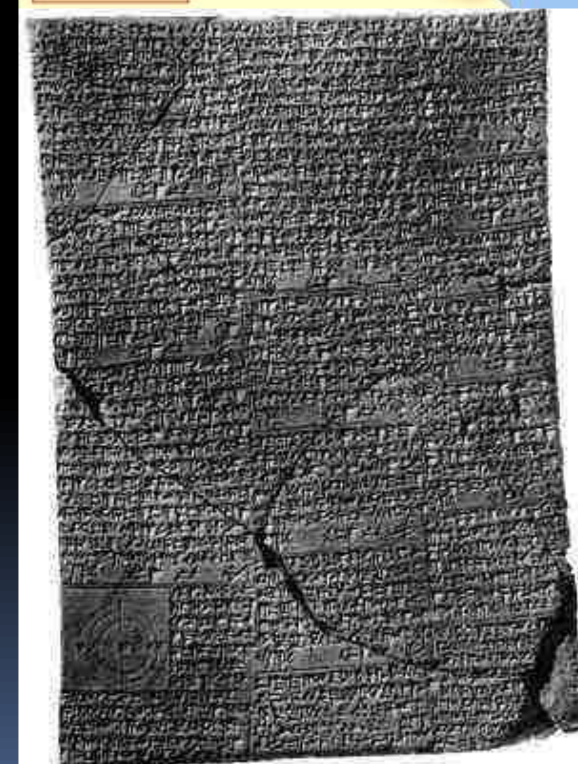
If r is the radius of the circle, the perimeter of the hexagon is $H = 6r$, the circumference of the circle $C = 2\pi r$, so that the ratio is $\frac{H}{C} = \frac{6r}{2\pi r} = \frac{3}{\pi}$. So for them

$$\frac{3}{\pi} = \frac{57}{60} + \frac{36}{3600} = \frac{96}{100}.$$

Solving,

$$\pi = \frac{300}{96} = \frac{25}{8} = 3\frac{1}{8} = 3.125$$



Irrational questions

- By definition, an irrational number is one that:

A. Has a never ending decimal expansion, like for example 0.1212121212……
B. Cannot be expressed as the quotient of two integers.
C. Is the square root of an integer.
D. Is a number smaller than all positive numbers.
E. Is a number that doesn't make sense.

$\sqrt{2}$ says the world is flat.

Don't listen to her! She's not rational.

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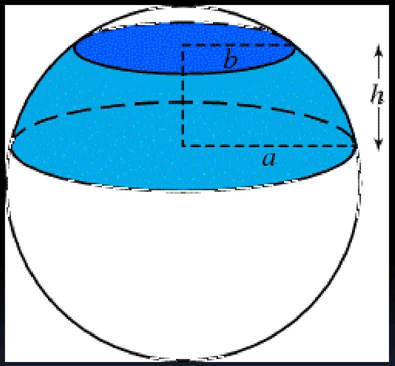
In the days of Archimedes

Archimedes (287-212 BCE) was one of the greatest mathematicians/physicists of all times. By a process similar to Calculus (2000 years before it was invented) he found that the volume of a sphere of radius r is given by $V = (4/3)\pi r^3$. Knowing this, which of the following could be a formula for a spherical segment of altitude h and base radii a, b.



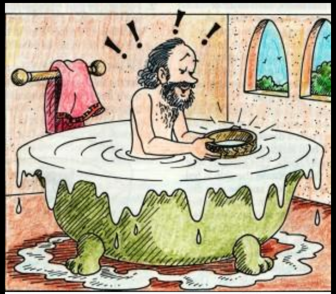
A. $V = \frac{4}{3}\pi h^3 ab$

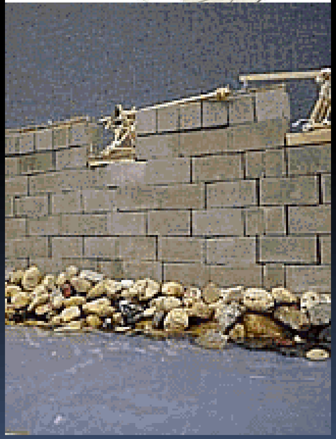
B. $V = \frac{4}{3}\pi (h + a + b)^3$

C. $V = \frac{1}{6}\pi h(a^2 + b^2 + h^2)$

D. $V = \frac{4}{3}\pi hab$

E. $V = \frac{1}{6}\pi h(3a^2 + 3b^2 + h^2)$





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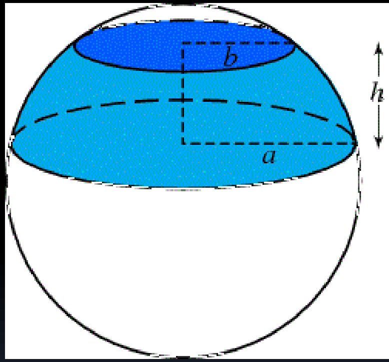

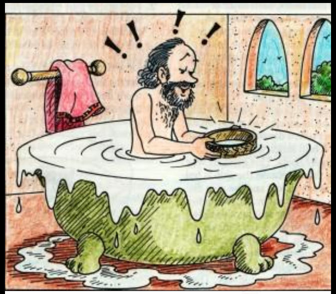

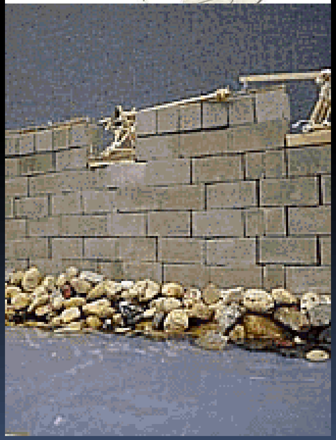

In the days of Archimedes

The last formula is the only one giving the correct volume of the half-sphere, namely $(4/6)\pi r^3$ when $a = h = r$, $b = 0$.

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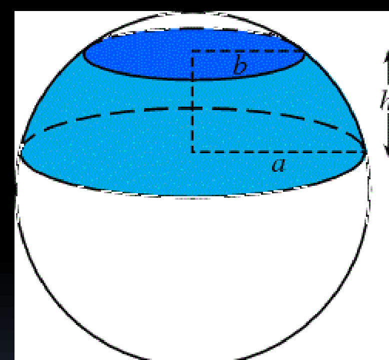

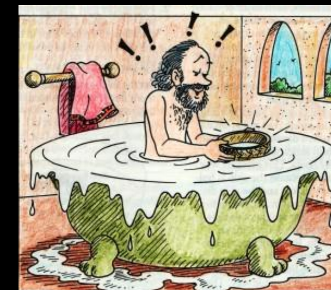

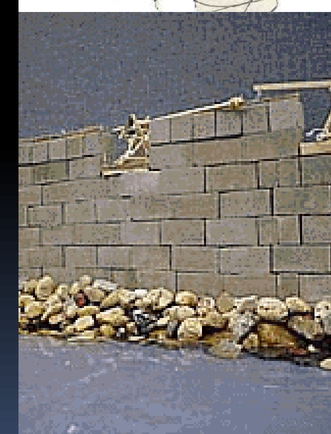

The European Middle Ages

- His most famous book begins: “These are the nine figures of the Indians: 9, 8, 7, 6, 5, 4, 3, 2, 1. With these nine figures, and with the sign 0, which in Arabic is called zephirum, any number can be written…” He was Leonardo of Pisa, better known as

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A page from Liber Abaci (Published 1202)

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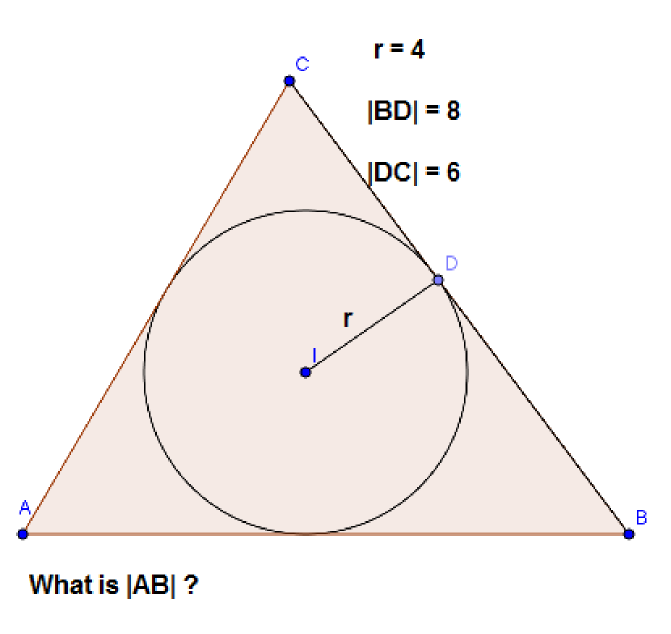
- In “Liber Abaci,” Fibonacci introduced the Arabic numbering into Europe. It is also where his famous sequence first appears, as solution to a rabbit question.

A page from Liber Abaci (Published 1202)

A problem by Luca Pacioli



Luca Pacioli, at work on his Summa de arithmetica, proportione et proportionalita (1494)

The radius of the incircle of a triangle is 4; side BC is divided into segments 8 and 6 by the point of contact. How long is |AB|?

A. 13
B. 14
C. 15
D. 16
E. Not enough information to tell.

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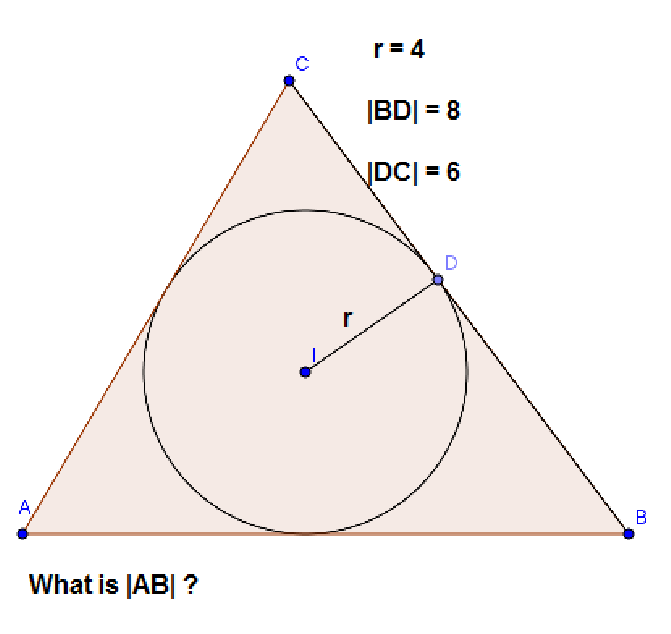

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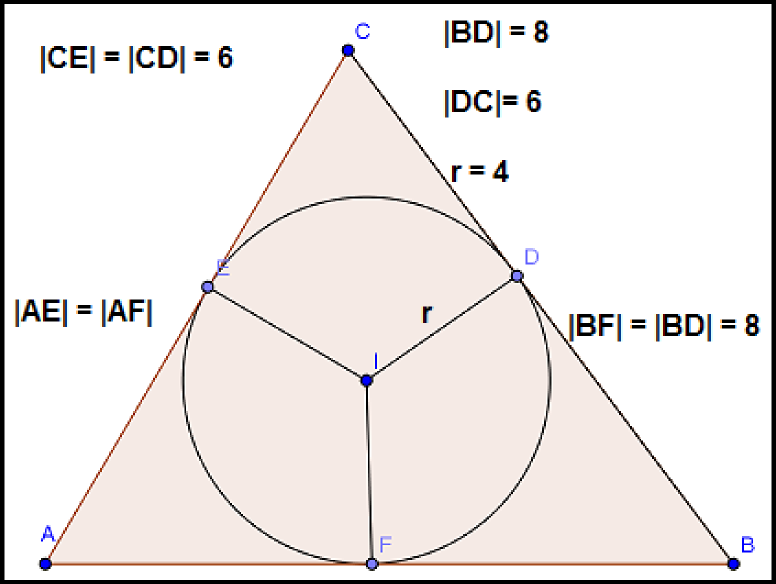

Put $a = |BC| = 8+6 = 14$, $b = |AC|, c = |AB|$. Let $s = \frac{a+b+c}{2}$ be the semi-perimeter. The area of the triangle is rs, so by Heron's formula, $(rs)^2 = s(s-a)(s-b)(s-c)$; canceling s, using $r = 4$, $16s = (s-a)(s-b)(s-c)$. Now $s - b = \dfrac{a+c-b}{2}$ and $c - b = |AB| - |AC| = |FB| - |EC| = 8-6 = 2$ Thus $s-b = (14+2)/2 = 8$. Similarly one sees $s-c = (14-2)/2 = 6$. Thus $16s = (s-14)\cdot 8 \cdot 6$; solving for s, $s = 21$, so from $s-c = 6$ we now get $|AB| = c = 15$.

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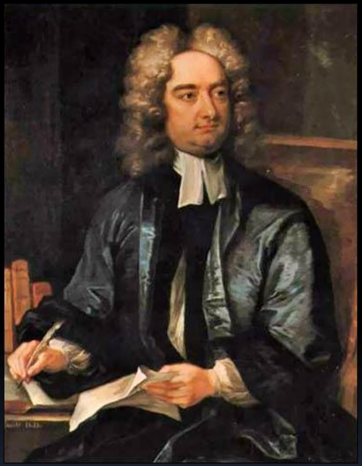
Traveling with Gulliver

- On his third voyage, Gulliver visits a land of mathematicians and he is served a pudding in the shape of a:

A. Cycloid.
B. Paraboloid
C. Ellipsoid.
D. Perfect sphere.
E. Cardioid.



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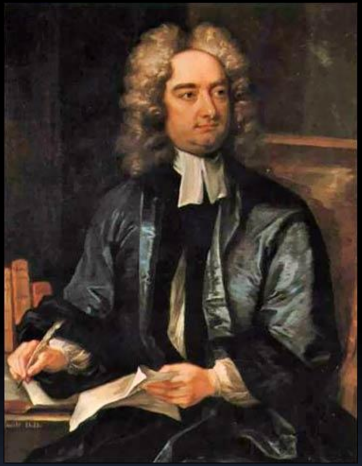

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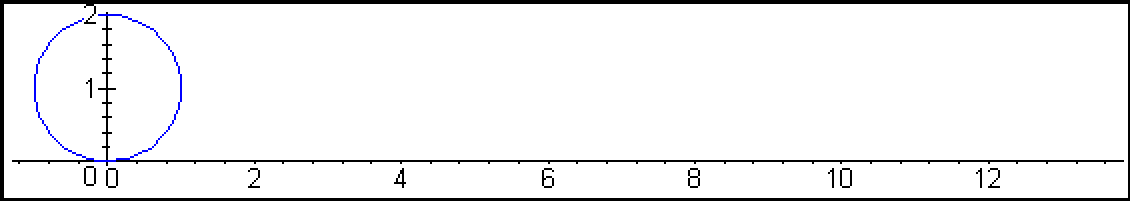

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A cycloid is the curve described by a point on a circle that rolls without slipping. Cycloids were studied by Pascal, the Bernoullis, Huygens, among others.

Circle in the Triangle

- The radius of the incircle (inscribed circle) in the **equilateral** triangle ABC is $r = 1$. Find the area of the triangle.

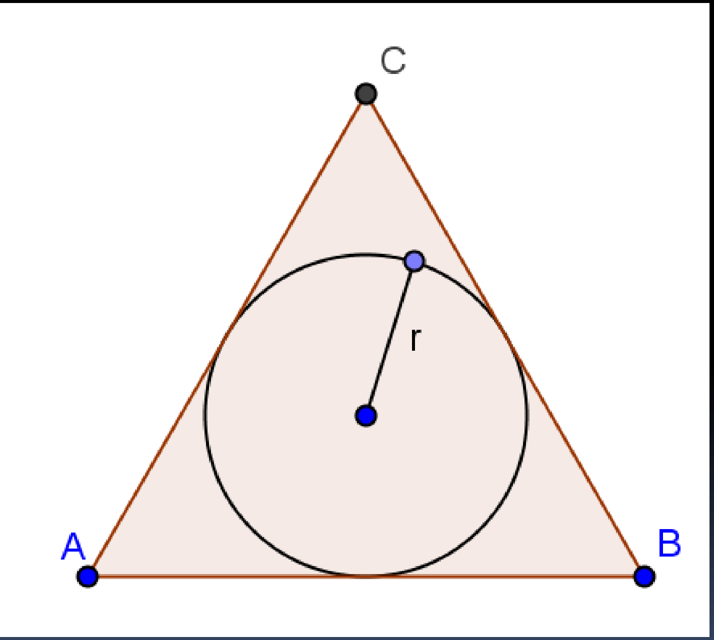
A. $\pi + \sqrt{2}$

B. $\pi + \sqrt{3}$

C. $2\sqrt{3}$

D. $3\sqrt{3}$

E. $3\sqrt{2}$



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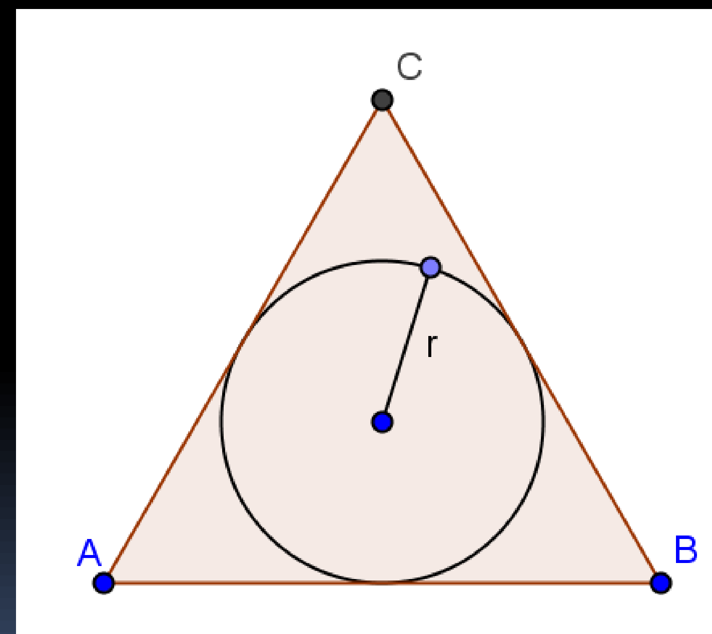

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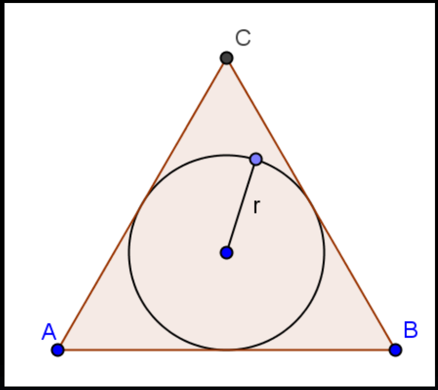

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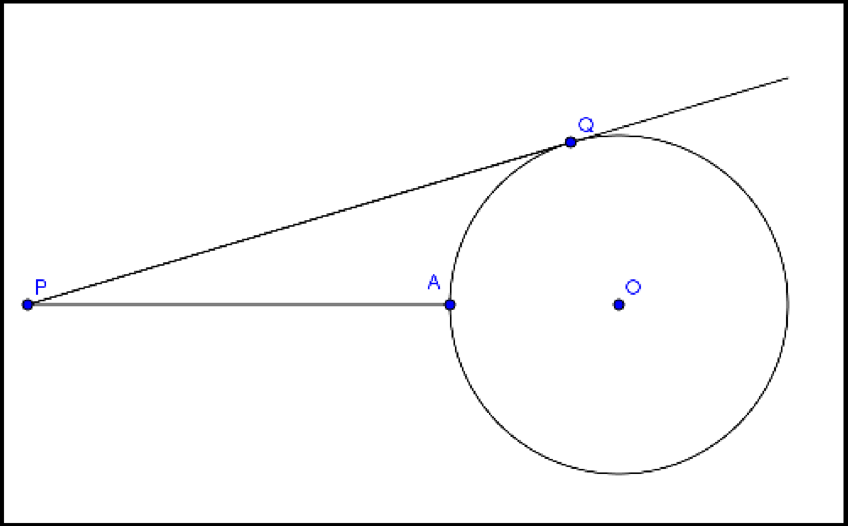
The triangle being equilateral, the center of the inscribed circle is 1/3 up the altitude, making the altitude h of the triangle equal to 3. By Pythagoras, the sides work out to $a = b = c = 2\sqrt{3}$. The area is thus $A = \frac{1}{2}(2\sqrt{3})3 = 3\sqrt{3}$.

MicroSoft Powerpoint meet…

Points P, A, Q are collinear (on the same line). The line PQ is tangent to the circle at Q.
|PA| = 5
|PQ| = 7
What is the radius of the circle?

A. 2
B. 2.2
C. 2.4
D. 2.5
E. 2.75



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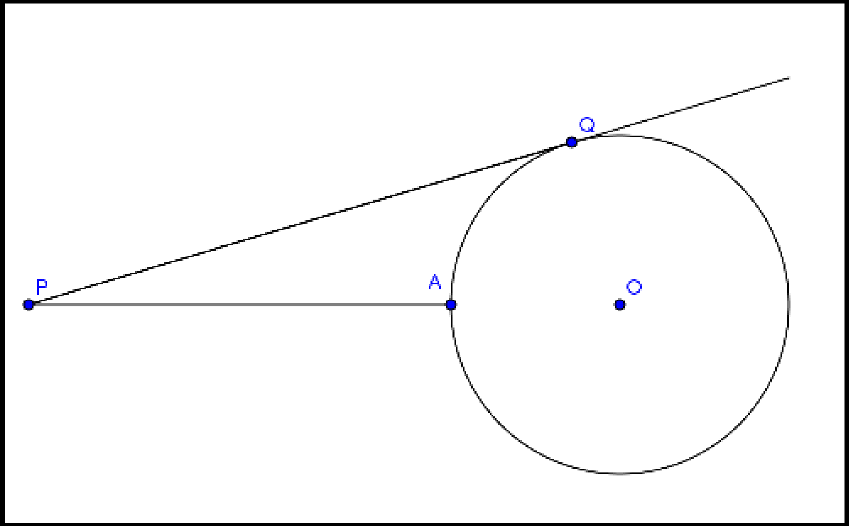

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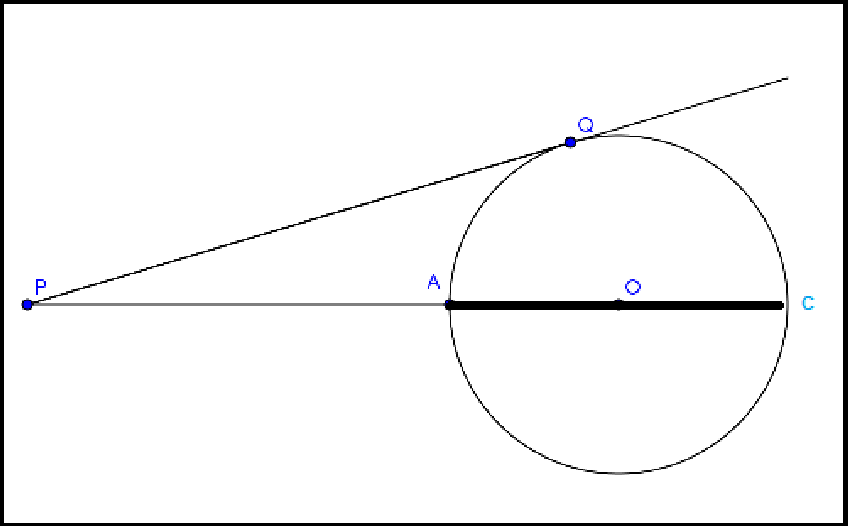

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The so called *power of a point* with respect to a circle is constant, meaning $|PA| \cdot |PC| = |PQ|^2$. Now $|PC| = |PA| + 2r$, thus $5 \cdot (5+2r) = 49$. Solving for $r = 24/10 = 2.4$

A Bologna sandwich

University of Bologna--Founded 1088

- Girolamo Cardano (1501-1576) swore the following to Niccolo Tartaglia (1499-1557): *I swear to you, by God's holy Gospels, and as a true man of honour, not only never to publish your discoveries, if you teach me them, but I also promise you, and I pledge my faith as a true Christian, to note them down in code, so that after my death no one will be able to understand them.*
- What was the discovery:

A. A formula to solve cubic equations.

B. How to trisect angles.

C. Squaring the circle.

D. Calculus.

E. How to cure the common cold.

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The *cubic formula* was one the first discoveries by European mathematicians that went further than what the Greeks had done centuries before. Tartaglia claimed to have it (he did) and Cardano just needed to know. After he swore to never divulge it, Tartaglia revealed the secret. Soon afterwards, Cardano published the formula. Tartaglia spent the rest of his life trying to get revenge.

But the truth is not so simple, Cardano actually had a good reason.

Augustus DeMorgan

- Augustus DeMorgan was a famous 19th century mathematician. He once said: I was *x* years old in the year x^2. In what year was DeMorgan born?

A. 1864
B. 1825
C. 1816
D. 1806
E. 1800

De Morgan laws

If A, B are sets and A^c, B^c are their complements, then

$$(A \cup B)^c = A^c \cap B^c$$
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Between 1800 and 1900 there is only one perfect square: $1849 = 43^2$. Now,

$$1849 - 43 = 1806.$$

A Russian Childhood

This Russian mathematician had to marry to be allowed to leave her home and study in Germany. It took a special request by university professors impressed by her ability to even let her study at Heidelberg, she was not allowed to attend classes later on at Berlin, being then privately tutored by a famous professor. At age 25 she published (among others) the paper containing the theorem that still bears her name. Even so, she was unable to get a university position. She finally found a haven in Sweden. She was:

A. Sofia Kovaleskaya
B. Olga Ladyzhenskaya
C. Olga Oleinik
D. Pelageia Kochina
E. Anna Karenina

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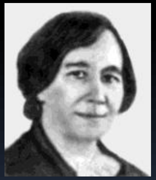
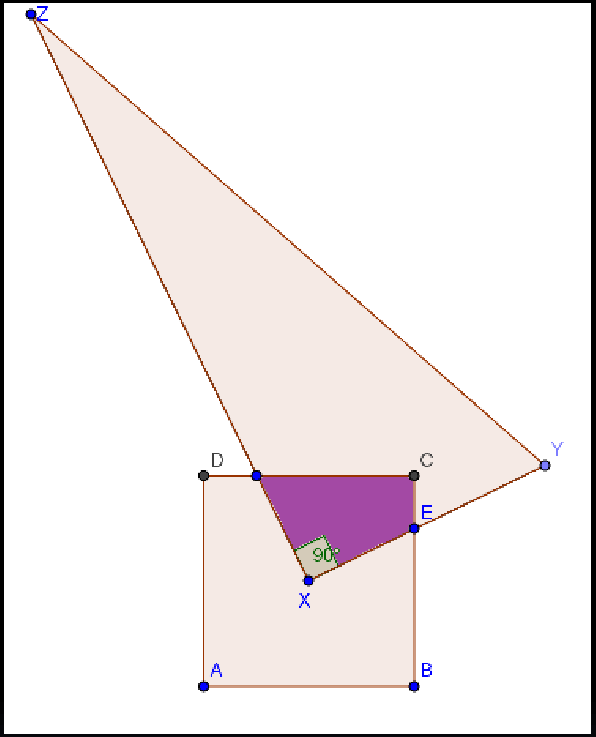


Ladyzhenskaya, Oleinink, Kochina also were important mathematicians, especially Ladyzhenskaya. Anna Karenina was not.

Triangle and square

ABCD is a square of center X and side length 8 (|AB| = 8). XYZ is a right triangle with right angle at X and |XY| = 10, |XZ| = 24. If XY intersects BC at E such that |CE| = 2, and |EB| = 6, find the area of the region that is common to the triangle and the square.



A. 16
B. $5\sqrt{3}$
C. $6\sqrt{2}$
D. $2\sqrt{3} + 3\sqrt{2}$
E. Not enough information to tell.

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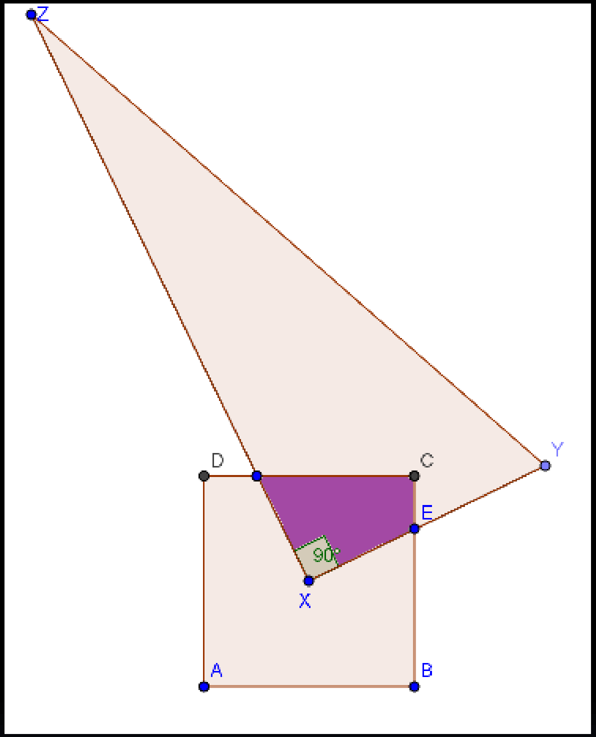
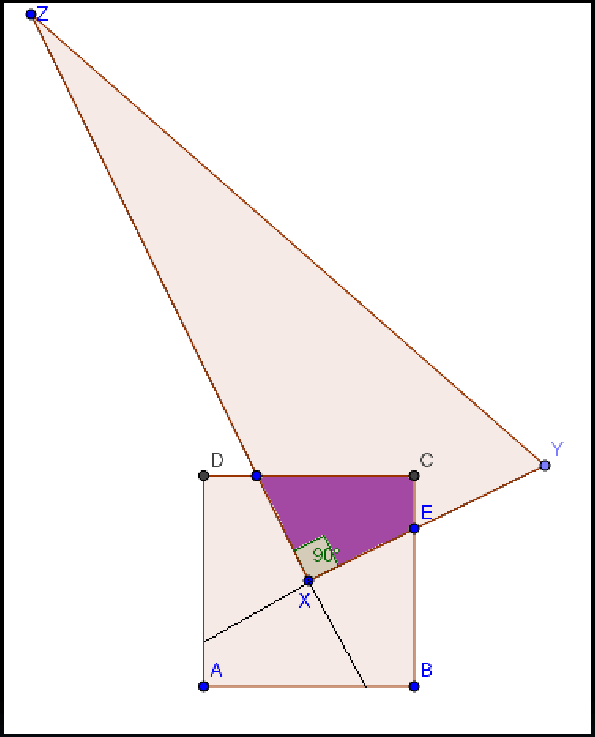


A. 16
B. 5 √3
C. 6√2
D. 2 √3 + 3 √2
E. Not enough information to tell.

Triangle and square

ABCD is a square of center X and side length 8 (|AB| = 8). XYZ is a right triangle with right angle at X and |XY| = 10, |XZ| = 24. If XY intersects BC at E such that |CE| = 2, and |EB| = 6, find the area of the region that is common to the triangle and the square.

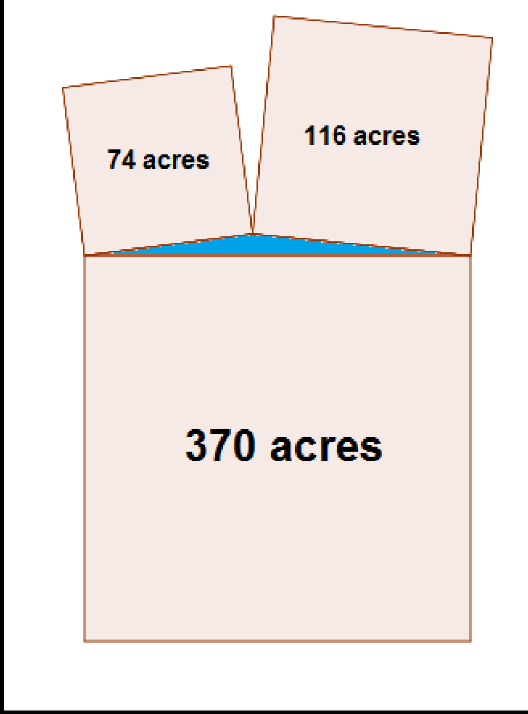


A. 16
B. 5 √3
C. 6√2
D. 2 √3 + 3 √2
E. Not enough information to tell.

This problem came with a lot of superfluous information. This is related to this year's T-shirt. With the added lines it should be clear that the common region has area one fourth that of the square.

From Sam Loyd's *Cyclopedia*

The picture shows a blue triangle; with a square on each one of its sides. The areas of the squares are as given. What is the area in acres of the blue triangle? (You do not need to know what an acre is to solve the problem. You can replace acres by square feet, for example.)



A. 18.5
B. 16
C. 12.5
D. 11
E. 10

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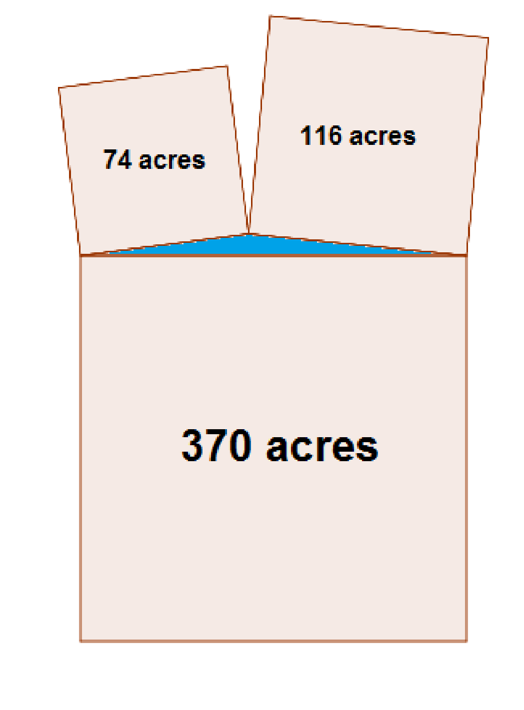

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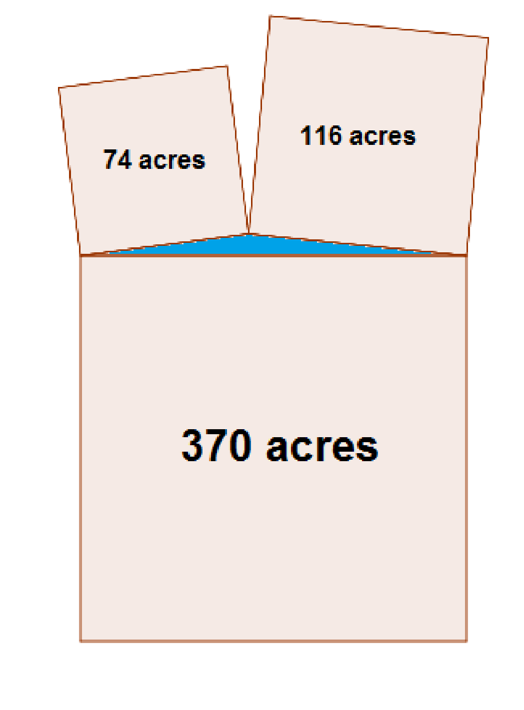

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With a calculator, the easiest approach could be using Heron's formula. But that leaves the doubt, is the answer really exactly 11? A perhaps better approach is to use the law of cosines to see that the cosine of the obtuse angle (lets call it A) is

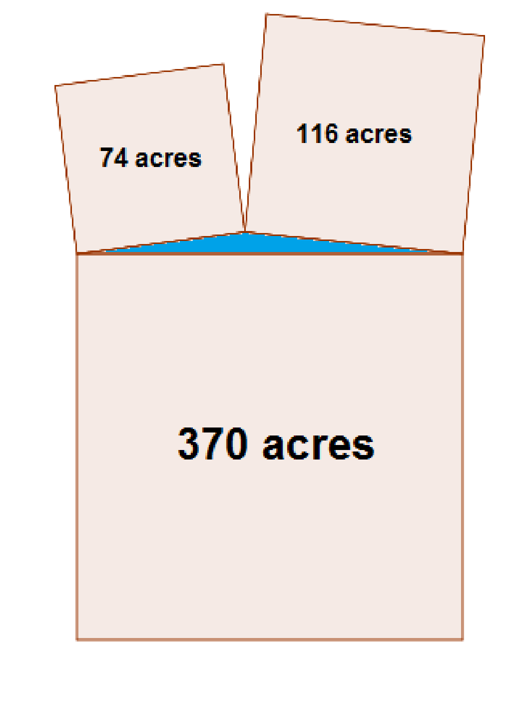
$$\cos A = -\frac{180}{2\sqrt{74}\sqrt{116}}.$$

From this one gets

$$\sin A = \sqrt{1-\cos^2 A} = \frac{\sqrt{1936}}{2\sqrt{74}\sqrt{116}} = \frac{\sqrt{22}}{\sqrt{74}\sqrt{116}}.$$

Thus

$$\text{Area} = \frac{1}{2}\sqrt{74}\sqrt{116}\sin A = 11.$$



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From a 1970's Contest

In the figure, AB is parallel to CD.
The angle at D is twice the size of the angle at B.

|AD| = a, |CD| = b

Then |AB| is equal to

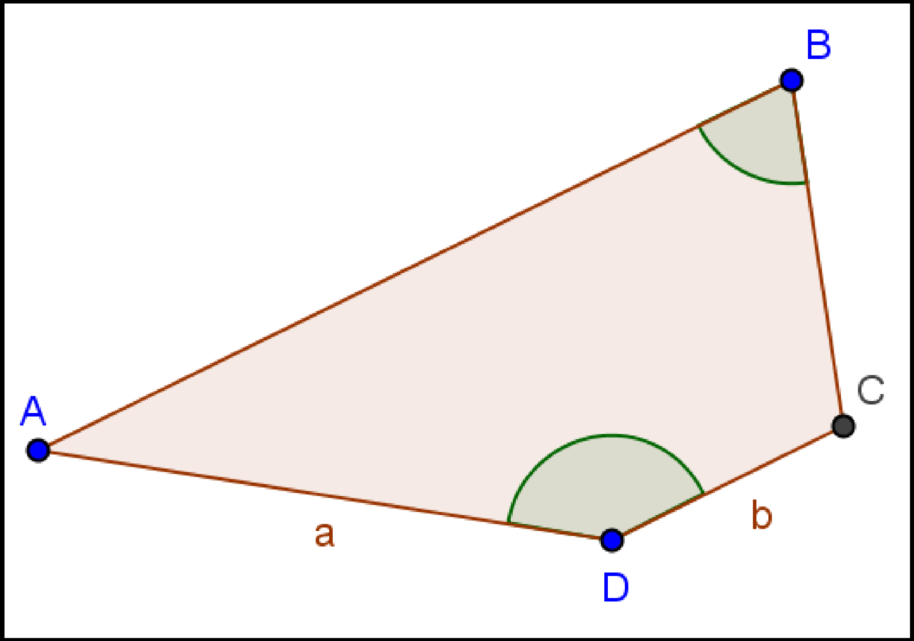
A. ½ a + 2b

B. $^3/_2$ b + $^3/_4$ a

C. 2a – b

D. 4b – ½ a

E. a + b



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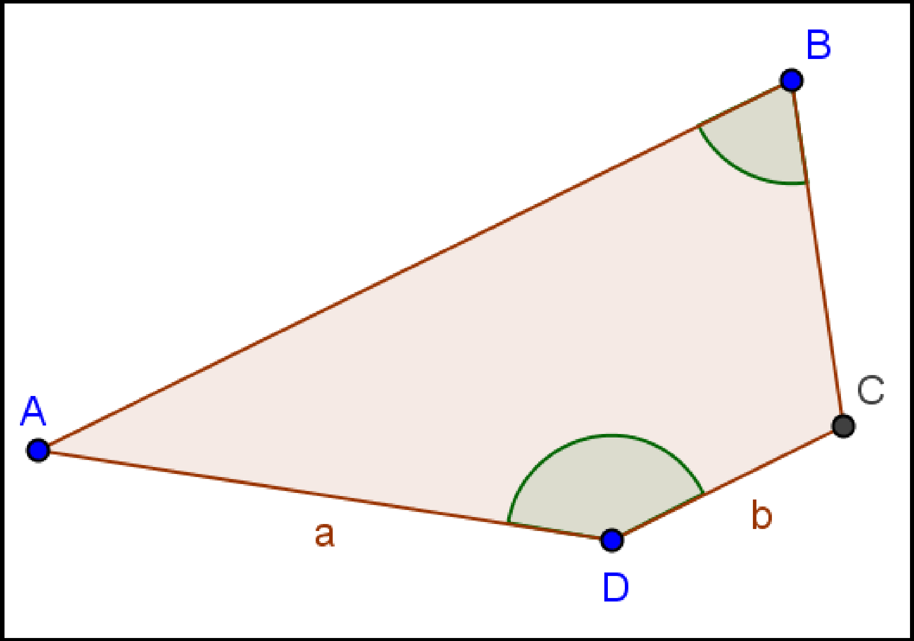


From a 1970's Contest

In the figure, AB is parallel to CD.
The angle at D is twice the size of the angle at B.

$|AD| = a, \quad |CD| = b$

Then $|AB|$ is equal to

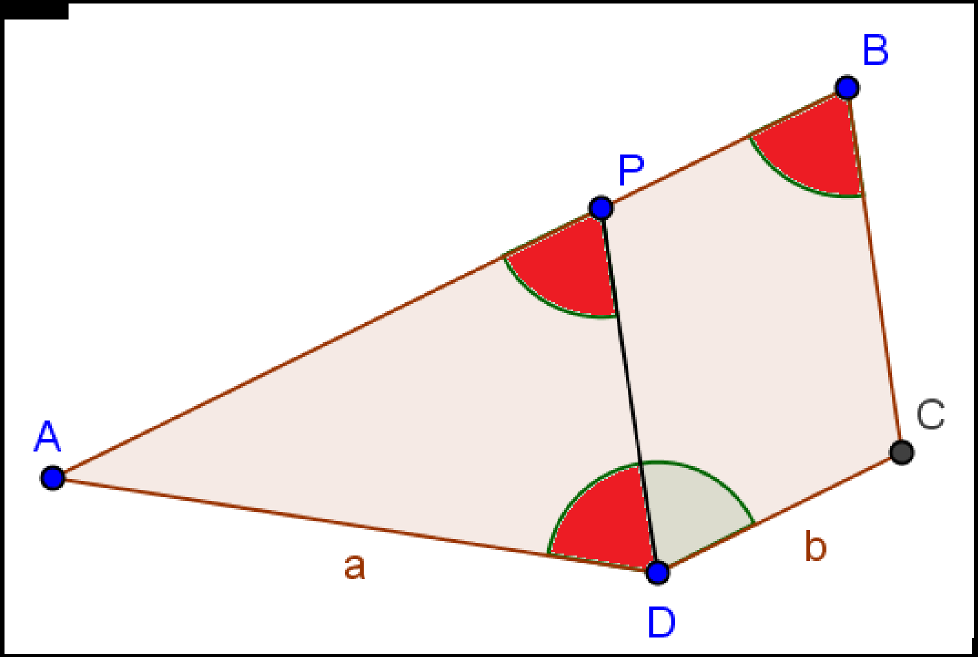
A. $\frac{1}{2} a + 2b$

B. $^{3}/_{2}\, b + {}^{3}/_{4}\, a$

C. $2a – b$

D. $4b – \frac{1}{2} a$

E. $a + b$



If we draw the line PD parallel to BC, we see that all the red angles are equal, so APD is isosceles.

Curiouser and curiouser

- Which of these mathematicians became convinced that someone was trying to poison him, so he stopped eating, and died from starvation.

A. Leonhard Euler.
B. Niels Henryk Abel.
C. Carl Friedrich Gauss.
D. Kurt Gödel.
E. Bertrand Russell

Breaking Ties

From now on, only the scores of the teams having the highest scores will be considered.

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Gödel's work was in mathematical logic. His 1930's results caused a crisis and a revolution in mathematics. He came to the U.S. in 1940 and became a memberof the IAS in Princeton, and a close friend of Albert Einstein.

Friends of Diophantus

- If x and y are **positive** integers and

$xy + 5y + 7x = 168$,

then $x + y$ equals

A. 6

B. 12

C. 24

D. 48

E. 96

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$xy+5y+7x$ is how the product $(x+5)(y+7)$ would begin; $xy+5y+7x=(x+5)(y+7)-35$ so that our equation is, after adding 35 to both sides, $(x+5)(y+7)=203=7\cdot 29$. Since $7, 29$ are primes, one of $x+5, y+7$ must be 7, the other one 29. But for $y>0$, we can't have $y+7=7$. Thus $x+5=7, y+7=29$, so $x=2, y=22$ and $x+y=24$.

Q1. The sentence: *Certainly one would wish for a stricter proof here; I have meanwhile temporarily put aside the search for this after some fleeting futile attempts, as it appears unnecessary for the next objective of my investigation*

initiates the search for the solution of a famous problem. Who wrote it, and what is the problem?

A. Pierre Fermat; *Fermat's last theorem.*

B. Christian Goldbach, *The Goldbach conjecture.*

C. Carl Friedrich Gauss, *The parallel postulate.*

D. Bernhard Riemann, *The Riemann hypothesis.*

E. Bertrand Russell, *The Russell paradox.*

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Q4. Which U.S president came up with a proof of the Theorem of Pythagoras, which was later published?

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E. Emily Noether.

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B. Johannes Müller, Regiomontanus.

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Q10. Which of these regular polygons is NOT constructible using only a compass and a straightedge?

A. The regular polygon of 85 sides.

B. The regular polygon of 119 sides.

C. The regular polygon of 3855 sides.

D. The regular polygon of 4369 sides.

E. The regular polygon of 196,611 sides.

Q10. Which of these regular polygons is NOT constructible using only a compass and a straightedge?

A. The regular polygon of 85 sides. $85 = 5\times17$

B. The regular polygon of 119 sides. $119 = 7\times 17$

C. The regular polygon of 3855 sides. $3855 = 3 \times5 \times257$

D. The regular polygon of 4369 sides. $4369 = 17 \times257$

E. The regular polygon of 196,611 sides. 3×65537

Q12. Evariste Galois was born in 1811 and died in 1832, not quite 21 years old. In what year was his first paper published:

A. 1828.

B. 1829.

C. 1830.

D. 1831.

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The series for the inverse tangent, namely
Is usually known as Gregory’s series, as is
the series you get setting x =1. But two centuries before Gregory (who lived 1638-1675), and before Newton, an Indian mathematician already had discovered all this. The name of this Indian mathematician is

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