

For all questions, answer choice (E) *NOTA* means that none of the given answers is correct. Diagrams are not necessarily drawn to scale.

For Problems 1 and 2: Assume that a flute is a hollow, perfect cylinder of length 3 feet 2 inches and that the inner and outer diameters of the flute are 1 inch and 1.2 inches respectively.

- What is the volume of air contained in the flute in cubic inches?
 (A) 8π (B) $\frac{19\pi}{2}$ (C) $\frac{38\pi}{2}$ (D) 38π (E) *NOTA*
- Given that the flute is made out of silver and the price of silver is 50.00 USD per cubic inch, how much will the metal for the flute cost in USD?
 (A) 50π (B) 100π (C) 109π (D) 209π (E) *NOTA*
- Find the area bounded by the function $f(x) = \pm\sqrt{16 - x^2}$.
 (A) 2π (B) 4π (C) 8π (D) 16π (E) *NOTA*
- Paulina is eating mango sorbet out of a right circular cone. The cone has height of 10 cm and radius of 4 cm. While she is eating the sorbet at a rate of $\frac{20\pi}{3}$ cm³ per minute, Stephen is filling the cone with more mango sorbet at a rate of 4π cm³ per minute. Assuming the cone was initially full, how much mango sorbet is left in cm³ after 4 minutes?
 (A) $\frac{32\pi}{3}$ (B) $\frac{64\pi}{3}$ (C) $\frac{128\pi}{3}$ (D) $\frac{160\pi}{3}$ (E) *NOTA*
- Find the sum of the following, and then subtract 7 to find the answer to this question.
 The number of sides on a dodecagon.
 The interior angle of a regular octagon.
 The sum of the exterior angles of a pentagon.
 (A) 135 (B) 147 (C) 500 (D) 507 (E) *NOTA*
- Three congruent equilateral triangles are joined to form a trapezoid. The sides of each triangle measure 3 cm. What is the area in cm² of the trapezoid?
 (A) $\frac{9\sqrt{3}}{4}$ (B) $\frac{9\sqrt{3}}{2}$ (C) $\frac{27\sqrt{3}}{4}$ (D) $\frac{27\sqrt{3}}{2}$ (E) *NOTA*
- There are two congruent circles of radius 5. Each circle passes through the center of the other circle. What is the area of intersection of the two circles?
 (A) 25π (B) $\frac{25\pi}{3} - \frac{25\sqrt{3}}{4}$ (C) $\frac{25\pi}{4} - \frac{25\sqrt{3}}{3}$ (D) $\frac{50\pi}{3} - \frac{25\sqrt{3}}{2}$ (E) *NOTA*

8. Siddarth and Sumanth are playing tug of war with a 50 ft rope. Sumanth is winning and making fun of Siddarth; this distracts Sumanth because of his inability to stop gloating. Siddarth quickly increases the force with which he is pulling, and Sumanth falls down on the ground. As Sumanth is lying, dazed on the ground, he sees circles of radius 4. Which of the following equations is that of a circle with radius 4?
- (A) $(x - 2)^2 + (y + 2)^2 = 36$
 (B) $(x - 4)^2 + (y + 4)^2 = 25$
 (C) $(x + 2)^2 + (y - 2)^2 = 49$
 (D) $(x + 4)^2 + (y - 4)^2 = 9$
 (E) NOTA
9. Johann Sebastian Bach is teaching his son, Carl Phillip Emmanuel, how to properly compose a chorale in 4-part harmony. C.P.E. Bach is not particularly interested in the lesson and is doodling on his paper instead. He draws a regular hexagon on his paper and then draws a square with one edge being shared with an edge on the hexagon. The length of one side of his hexagon is 7 feet. What is the perimeter in feet of the figure he has doodled?
- (A) 49 (B) 56 (C) 63 (D) 70 (E) NOTA
10. Peter and Kyle are both headed off to Rice University this year and as a graduation present they both received a diploma frame. Peter's diploma frame measures 8 inches by 10 inches, whereas Kyle's frame measures 13 inches by 16 inches. How much longer is the diagonal of Kyle's frame than Peter's frame?
- (A) $2\sqrt{41}$ (B) $2\sqrt{17}$ (C) $5\sqrt{17} - 2\sqrt{41}$ (D) $5\sqrt{11} - 2\sqrt{42}$ (E) NOTA
11. A quadrilateral has diagonals that are perpendicular and does not have all sides of equal length. What type of quadrilateral does this describe?
- (A) Rhombus (B) Parallelogram (C) Rectangle (D) Trapezoid (E) NOTA
12. Find the radius of a sphere that is inscribed in a right circular cone of radius 4 and height 3.
- (A) $\frac{4\pi}{3}$ (B) $\frac{4}{3}$ (C) $\frac{2}{3}$ (D) $\frac{256\pi}{81}$ (E) NOTA
13. What is the area in cm^2 of a cross section 4 cm from the center of a sphere with radius 5 cm?
- (A) 9π (B) 16π (C) 25π (D) 50π (E) NOTA

For questions 14 and 15, there is a triangle of sides 15, 16, and 17.

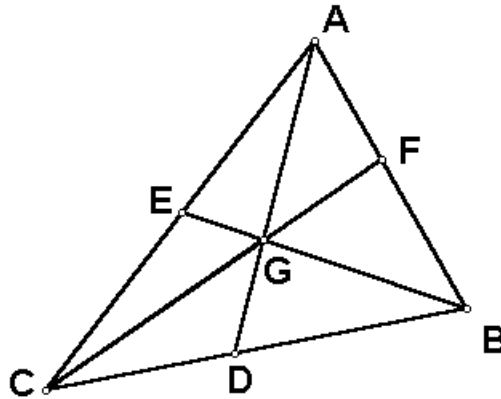
14. What is the area of this triangle?
- (A) 16 (B) $21\sqrt{21}$ (C) $24\sqrt{21}$ (D) $28\sqrt{21}$ (E) NOTA
15. What is the length of the angle bisector to the side with length 16?
- (A) $\frac{4\sqrt{85}}{3}$ (B) $\frac{\sqrt{51}}{2}$ (C) $\frac{3\sqrt{85}}{2}$ (D) $2\sqrt{51}$ (E) NOTA
16. There is a square that circumscribes a circle that circumscribes a square that circumscribes a circle. What is the ratio of the perimeter of the smaller circle to the larger circle?
- (A) $\frac{\sqrt{2}}{2}$ (B) $\sqrt{2}$ (C) $\frac{1}{2}$ (D) 2 (E) NOTA

17. Teja has found a new pet (let's call him Bessie) and he decides to tie his pet up in the yard while he goes out to get groceries. Bessie is tied to the corner of a rectangular house with length 5 feet and width 10 feet. The house is in the center of the yard, and the yard of this house is rectangular with length 18 feet and width 20 feet. Teja will place a chew toy randomly in the yard. What is the probability that Bessie will be able to reach the chew toy given that he is tied up with a rope of length 4 feet?
- (A) $\frac{3\pi}{50}$ (B) $\frac{2\pi}{25}$ (C) $\frac{\pi}{30}$ (D) $\frac{2\pi}{75}$ (E) NOTA
18. For the 2014 James S. Rickards Invitational, only 8 of the tests were turned in on time, which means 13 tests were not finished on time (including this one!). As punishment for this atrocity, our presidents Jenny and Siddarth force all of the insubordinate test writers to wear dunce caps to school. The dunce caps are right, circular, and baseless cones with a radius of 3 feet and height of 6 feet. What is the area of material required to build one of these dunce caps? Assume all answers are in feet.
- (A) $9\pi\sqrt{5} + 36\pi$ (B) 9π (C) $9\pi(\sqrt{5} + 1)$ (D) 18π (E) NOTA
19. AB and CD are perpendicular chords of a circle that intersect at E . $AE = 4$, $EB = 5$, $CE = 10$, and $ED = 2$. What is the diameter of the circle?
- (A) $3\sqrt{15}$ (B) $\sqrt{145}$ (C) 20 (D) 14 (E) NOTA
20. Using the information from Problem 19, what is the shortest distance from the center of the circle to the chord of length 12 (chord CD)?
- (A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) $\frac{1}{3}$ (D) $\frac{2}{3}$ (E) NOTA
21. What is the maximum number of sections that 10 lines can divide a plane into?
- (A) 37 (B) 46 (C) 56 (D) 67 (E) NOTA
22. What is the cosine of 60° ?
- (A) $\frac{1}{2}$ (B) $\frac{\sqrt{2}}{2}$ (C) $\frac{\sqrt{3}}{2}$ (D) $\sqrt{3}$ (E) NOTA
23. On triangle PTW , the midpoints of PT , TW , and PW form a triangle with area $\frac{3}{4}$. What is the area of triangle PTW ?
- (A) $\frac{9}{4}$ (B) $\frac{4}{3}$ (C) 1 (D) 3 (E) NOTA
24. There is a square $ABCD$ that circumscribes a triangle DEF . E is the midpoint of side AB and F is the midpoint of side BC . What is the area in square feet of triangle DEF given that one side of the square is 4 feet in length?
- (A) 1 (B) 2 (C) $4\sqrt{2}$ (D) 6 (E) NOTA
25. Annie has been pestering Mihir to hang out with her lately, but Mihir has been avoiding her. Unfortunately, he sees Annie at Starbucks and quickly heads off in his car, traveling North at 70 mph. Annie starts driving in the same direction at the same time, but alas her car cannot drive faster than 20 mph, which is how fast she goes immediately. After 2 hours and 45 minutes, how much farther ahead is Mihir?
- (A) 50 miles (B) 100 miles (C) 137.5 miles (D) 135 miles (E) NOTA

26. Congratulations on making it this far into the test! As a reward, you will receive hexagonal cookies (not really). In order to make these cookies for you, I had to cut each cookie from a circular slice of cookie dough. If I minimized the amount of cookie dough removed from the original slice, what is the ratio of the removed cookie dough to the circular slice of cookie dough?

(A) $\frac{1 - 3\sqrt{2}}{2\pi}$ (B) $4 - \frac{3\sqrt{2}}{2\pi}$ (C) $\frac{2\pi - 3\sqrt{3}}{\pi}$ (D) $\frac{2\pi - \sqrt{2}}{2\pi}$ (E) NOTA

27. Triangle ABC has the following side lengths: $\overline{AB} = 14$, $\overline{CB} = 22$, $\overline{CD} = 10$, and $\overline{BF} = 8$. What is the ratio of the length of \overline{AE} to the length of \overline{CE} ?



(A) $\frac{4}{5}$ (B) $\frac{7}{11}$ (C) $\frac{3}{4}$ (D) $\frac{9}{10}$ (E) NOTA

28. Abhi draws the line $y = x$ from $x = 0$ to $x = 2$ and shades in the area bounded by the line, x -axis, and $x = 2$. Abhi takes his shaded area and revolves it around the x -axis. What is the volume of the resulting figure?

(A) $\frac{8\pi}{3}$ (B) $\frac{10\pi}{3}$ (C) 4π (D) 8π (E) NOTA

29. What is the lateral surface area of the figure described in Problem 28?

(A) $4\pi\sqrt{2}$ (B) $8\pi\sqrt{2}$ (C) $4\pi\sqrt{2} + 4\pi$ (D) $8\pi\sqrt{2} + 4\pi$ (E) NOTA

30. There is a right triangle that is inscribed in a circle. The hypotenuse is twice as long as the shortest side length. If the circle has circumference 24π , then what is the inradius of the triangle?

(A) $10\sqrt{3} - 10$ (B) $12\sqrt{3} - 12$ (C) 12 (D) $10\sqrt{3}$ (E) NOTA