Trigonometry - Advanced problems

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Source: *Taken from www.artofproblemsolving.com*

Problem	Solution 1	Solution 2	Solution 3
1. 1963 AHMSE Problem 34	✓		
2. 1973 AHMSE Problem 17	✓		
3. 1988 AHMSE Problem 13	✓		
4. 1989 AHMSE Problem 14	✓		
5. 2003 AMC Problem 21	✓		
6. 2004 AMC Problem 21	✓		
7. 2006 iTest Problem 9			
8. 2006 iTest Problem 17	✓	✓	
9. 2007 AMC Problem 17			
10. 2007 iTest Problem 17	✓	✓	✓
11. 2008 iTest Problem 46	✓		
12. 2017 AMC Problem 7	✓		
13. 2020 AMC Problem 9			
14. 1993 U South Carolina Problem 10			
15. 1984 AIME Problem 13			

Problems

1963 AHSME Problem 34

1. In triangle $\triangle$DEF, side $d = \sqrt{3}$, side $e = \sqrt{3}$, and side $f > 3$. Let t be the largest number such that the magnitude of the angle opposite side f exceeds t. Find t.

1973 AHSME Problem 17

2. If α is an acute angle and $\sin(\frac{\alpha}{2}) = \sqrt{\frac{x-1}{2x}}$, then find $\tan(\alpha)$.

1988 AHSME Problem 13

3. If $\sin(j) = 3\cos(j)$, then what is $\sin(j) \cdot \cos(j)$?

1989 AHSME Problem 14

4. What is $\cot(10) + \tan(5)$?

2003 AMC Problem 21

5. An object moves 8 cm in a straight line from A to B, turns at an angle β, measured in radians and chosen from the interval $(0, \pi)$, and moves 5 cm in a straight line to C. What is the probability that $AC < 7$?

2004 AMC Problem 21

6. If $\sum_{n=0}^{\infty} \cos^{2n}\delta = 4$, what is the value of $\cos 2\delta$?

2006 iTest Problem 9

7. If $\sin(x) = -\frac{5}{13}$ and x is in the third quadrant, what is the absolute value of $\cos(\frac{x}{2})$?

2006 iTest Problem 17

8. Let $\sin(2x) = \frac{1}{7}$. Find the numberical value of $\sin(x)\sin(x)\sin(x)\sin(x) + \cos(x)\cos(x)\cos(x)\cos(x)$

2007 AMC Problem 17

9. Suppose that $\sin(a) + \sin(b) = \sqrt{\frac{5}{3}}$ and $\cos(a) + \cos(b) = 1$. What is $\cos(a - b)$?

2007 iTest Problem 17

10. If x and y are acute angles such that $x + y = \frac{\pi}{4}$ and $\tan(y) = \frac{1}{6}$, find the value of $\tan(x)$.

2008 iTest Problem 46

11. Let S be the sum of all x in the interval $[0, 2\pi)$ that satisfy $\tan^2(x) - 2\tan(x)\sin(x) = 0$. Compute $\lfloor 10S \rfloor$.

2017 AMC Problem 7

12. The functions $\sin(x)$ and $\cos(x)$ are periodic with least period 2π. What is the least period of the function $\cos(\sin(x))$?

2020 AMC Problem 9

13. How many solutions are there to the equation $\tan(3x) = \cos(x/2)$ on $[0, 2\pi]$?

1993 U South Carolina Problem 10

14. What is $\arcsin(\frac{1}{3}) + \arccos(\frac{1}{3}) + \arctan(\frac{1}{3}) + \operatorname{arccot}(\frac{1}{3})$?

1984 AIME Problem 13

15. What is $10\cot[\cot^{-1}(3) + \cot^{-1}(7) + \cot^{-1}(13) + \cot^{-1}(21)]$?