Calculus 1 Worksheet #16
Derivatives of Trigonometric Functions

Notes: Know the following theorems.

1. $\frac{d(\tan\square)}{dx} = \sec^2\square \bullet \frac{d\square}{dx}$	2. $\frac{d(\cot\square)}{dx} = -\csc^2\square \bullet \frac{d\square}{dx}$	3. $\frac{d(\sec\square)}{dx} = \sec\square \bullet \tan\square \bullet \frac{d\square}{dx}$	4. $\frac{d(\csc\square)}{dx} = -\csc\square \bullet \cot\square \bullet \frac{d\square}{dx}$

Examples:

1. $y = \tan 5x$ $y' = 5\sec^2 5x$	2. $y = \sec 5x$ $y' = 5\tan 5x \sec 5x$	3. $y = \cot^4 3x$ $y' = 4\left[-\cot^3 3x \csc^2 3x\right](3)$ $y' = -12\cot^3 3x \csc^2 3x$	4. $y = \csc^3 2x$ $y' = 3\left(\csc^2 2x\right)\left[-\csc 2x \cot 2x\right](2)$ $y' = \boxed{-6\left(\csc^2 2x\right)\csc 3x \cot 3x}$

Use the **quotient rule** to **prove** the derivative of: [Hint: change into sin x and cos x and then take derivative]
1. tan x 2. cot x 3. sec x 4. csc x

Directions: Find dy/dx.

5. y = sec4x	6. y = tan3x – cot3x	7. y = cot5x + csc5x
8. y = $\csc^3(2x)$	9. y = tanx + cotx	10. y = 4secx – 2cscx
11. $y = 3\sec x(\tan x)$	12. $y = \sin x(\tan x)$	13. $y = \cot x(\csc x)$
14. $y = \cos x(\cot x)$	15. $y = \frac{2\cos x}{x+1}$	16. $y = \frac{\sin x}{x}$
17. $y = \frac{\sin x}{1-\cos x}$	18. $y = \frac{x+2}{\cos x}$	19. $y = \frac{\tan x}{\cos x - 4}$
20. $y = \frac{\cot x}{1-\sin x}$		

Answers:

1. $\sec^2 x$	2. $-\csc^2 x$	3. $\sec x \tan x$
4. $-\csc x \cot x$	5. $4\sec 4x \tan 4x$	6. $3\left(\sec^2 3x + \csc^2 3x\right)$
7. $-5\csc 5x\left(\csc 5x + \cot 5x\right)$	8. $-6\csc^3(2x)\cot(2x)$	9. $\sec^2 x - \csc^2 x$
10. $2(2\sec x \tan x + \csc x \cot x)$	11. $3\sec x\left(\tan^2 x + \sec^2 x\right)$	12. $\sin x(1+\sec^2 x)$
13. $-\csc x(\csc^2 x + \cot^2 x)$	14. $-\cos x(1+\csc^2 x)$	15. $\frac{-2(x\sin x + \sin x + \cos x)}{(x+1)^2}$
16. $\frac{x\cos x - \sin x}{x^2}$	17. $\frac{1}{\cos x - 1}$	18. $\frac{\cos x + x\sin x + 2\sin x}{\cos^2 x}$
19. $\frac{\sec x - 4\sec^2 x + \tan x \sin x}{(\cos x - 4)^2}$	20. $\frac{-\csc^2 x + \csc x + \cot x \cos x}{(1-\sin x)^2}$	

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