1. If $f(x) = \tan^{-1}(\sin x)$, then $f'\left(\frac{\pi}{3}\right) =$

(a) $2/7$

(b) $2\sqrt{3}/5$

(c) $2/5$

(d) $4/5$

(e) $2/3$

2. The formula for the volume for a right circular cone is
    $V = \frac{1}{3}\pi r^2 h$ where r is the base radius and h is the height.
    Suppose the radius and height are changing but the volume
    is held constant at the instant $V = 5\,m^3$. Find the rate of
    change of height with respect to radius when $r = 1\,m$.

(a) $-30/\pi$

(b) $10\pi/3$

(c) $-15/\pi$

(d) $18/\pi$

(e) $25\pi/3$

3. Let $f(x) = \begin{cases} \frac{\sin^2(3x)}{2x} & \text{if} \quad x \neq 0 \\ 0 & \text{if} \quad x = 0 \end{cases}$ Find $f'(0)$?

(a) 9/2

(b) 9/4

(c) 3/4

(d) 0

(e) 81/4

4. Let $y = x - \dfrac{1}{\sqrt{x}}$. Write $y'(4) = a/b$ in lowest terms, where a and b are positive integers. What is $a + b$?

(a) 33

(b) 32

(c) 31

(d) 30

(e) 29

5. If $y(x) = (1 - x^2)(x^3 - 3x + 1)$. Find $y''(2)$?

   (a) -114

   (b) 114

   (c) 111

   (d) -111

   (e) 100

6. If $y(x) = x^2 \tan\left(\dfrac{1}{x}\right)$. Write $y'\left(\dfrac{4}{\pi}\right) = \dfrac{a}{\pi} - b$, where a and b are two positive integers. What is $a\,b$?

   (a) 16

   (b) 8

   (c) 2

   (d) 32

   (e) 4

7. A particle's position on a number line at time t seconds is $S(t) = t^3 - 12t^2 + 36t$ meters. Find the time when its acceleration is 0 ?

    (a) 4

    (b) 6

    (c) 3

    (d) 5

    (e) None of the above

8. $\lim\limits_{x \to \pi} \dfrac{e^{\tan x} - 1}{x - \pi} =$ (Hint: this limit is a derivative)

    (a) 1

    (b) -1

    (c) e

    (d) $-e$

    (e) 0

9.   Suppose that the functions $f(x)$, and $g(x)$ and their derivatives with respect to x have the following values at $x = 1$

x	$f(x)$	$f'(x)$	$g(x)$	$g'(x)$
1	-2	-1	2	7

The derivative of $f(\sec(\pi x) + g(x))$ with respect to x at $x = 1$ is

(a) -7

(b) -2

(c) 1

(d) 2

(e) 0

10.   Let $y(x) = \dfrac{1}{1 + \tan^2(x)}$. Suppose the y-intercept of the tangent line to the graph of $y(x)$ at $x = \dfrac{\pi}{4}$ is $\dfrac{a}{b} + \dfrac{\pi}{c}$, where a, b and c are positive integers with a/b in lowest terms. What is $a + b + c$?

(a) 7

(b) 8

(c) 9

(d) 10

(e) 5

11.   Let $h(x) = \dfrac{x + x^2}{1 + x^2}$. Find $h'(1)$?

   (a) 1/2

   (b) 3/2

   (c) 1

   (d) 5/2

   (e) −1/2

12.   At the point $x = 0$, the tangent line to the graph of
       $f(x) = \dfrac{e^{a\,x}}{a(x+1)^3}$ is horizontal. What is a ?

   (a) 3

   (b) 2

   (c) 1

   (d) −1

   (e) 0

13. If $f(x) = x^e e^x$. Calculate $f'(x)$?

   (a) $x^{e-1} e^{x+1} + x^e e^x$

   (b) $x^e e^x + x^{e+1} e^x$

   (c) $e x^{e-1} e^x$

   (d) $x^\pi e^x + x^e e^x$

   (e) $x^{e+1} e^{x-1}$

14. Find the equation of the tangent line to the graph of $y = \ln(x^4 + 1)$ at $x = 1$?

   (a) $y = 2x + \ln 2 - 2$

   (b) $y = 2x + 2 - \ln 2$

   (c) $y = 4x + \ln 2 - 2$

   (d) $y = 4x + 2 - \ln 2$

   (e) $y = (\ln 2)x - 2$

15.   If $f(x) = \dfrac{1}{\sqrt[3]{x^2 + x + 2}}$. Then $f'(2) =$

   (a) $-5/48$

   (b) $-5/18$

   (c) $-3/17$

   (d) $3/25$

   (e) $-1/2$

16.   Find the slope of the tangent line to the graph of
   $x^2 \cos y = 2y - e^{3x}$ at $\left(1, \dfrac{\pi}{2}\right)$?

   (a) e^3

   (b) $3e$

   (c) $\dfrac{2 + 3e^3}{2}$

   (d) $\dfrac{2 + 3e}{2}$

   (e) $\dfrac{3 + 2e}{2}$

17. Suppose that the length of a rectangle is decreasing at the rate of 3 cm/s while the width is increasing at a rate of 4 cm/s. Find the rate of change of the area when the length is 6 cm and the width is 4 cm ?

   (a) $12cm^2/s$

   (b) $36cm^2/s$

   (c) $16cm^2/s$

   (d) $8cm^2/s$

   (e) $20cm^2/s$

18. Let $f(x) = \dfrac{\sin x}{1 - \cos x}$. Find $f'\left(\dfrac{\pi}{2}\right)$?

   (a) -1

   (b) 1

   (c) $1/2$

   (d) $-1/2$

   (e) 0

19. If $f(x) = x^{x+1}$. Find $f'(x)$?

(a) $(x\ln x + x + 1)x^x$

(b) $(x\ln x + x + 1)x^{x+1}$

(c) $(x+1)x^{x+1}$

(d) $(\ln x + 1)x^{x+1}$

(e) $(x + \ln x)x^x$

20. Suppose $g(x)$ is a differential function. Find $g'(0)$ if $g(x) + x \sin g(x) = x^2 + 3x + \frac{\pi}{2}$.

(a) 2

(b) 1/2

(c) 3/2

(d) 1

(e) 0