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1) Use the limit definition of the derivative to explore why $|x|$ is not differentiable at the point $(0,0)$.

2) Differentiate the following functions:
   a) $f(x) = \frac{x^3+2x^2+x-1}{\sqrt{x}}$
   b) $g(x) = (3x^2-1)(x^2-\frac{1}{x})$

3) Differentiate the following functions:
   a) $h(x) = \frac{x^2-x+1}{(x-1)^{2/3}}$
   b) $k(x) = \begin{cases} -\frac{x^2-1}{x+2}, & x > -1 \\ x+2, & x \le -1 \end{cases}$
   c) $m(x) = \ln(\ln(e^x+1))$
   d) $n(x) = \sin^2(\cos(4x))$
   e) $q(x) = a^{2x} + x^{e^2} - e^{3x+1} + e^{4a}$, a is constant
   f) $p(x) = 5^{\tan^2(x)}$

4) Find…

$$\lim_{h\to 0} \frac{\sqrt[5]{x+h} - \sqrt[5]{x}}{h}$$

5) Take the derivatives of the following functions:
   a) $f(x) = 5^{\tan^2(x)}$
   b) $g(x) = x^{\sin(x)}$
   c) $h(x) = \frac{e^{3x+1}(x^2+3)^3}{\sqrt{2x-1}}$

6) Given $f(x) = 3x^2\sqrt[3]{4-x^2}$
   a) Find $\frac{df}{dx}$
   b) Where are the horizontal and vertical tangents?

7) Find a and b so that $g(x)$ is continuous and differentiable for all values of x, where

$$g(x) = \begin{cases} ax+4, & x < 1 \\ 3x^2+b, & x \ge 1 \end{cases}$$

8) It is known that there exists an implicit relationship between the variables x and y satisfying the relation below:

$$5x^2y - y^3 = 1 + x^2$$

   a) Find $\frac{dy}{dx}$.
   b) Find the equation of the tangent line to the curve at the point (1,2).

9) The functions $h(x)$ and $k(x)$ below are combinations of the differentiable functions $f(x)$ and $g(x)$.

$$h(x) = \frac{f(x)g(x)}{f(x) - g(x)}, \qquad k(x) = f^2(g(x) + x^2)$$

a) Find $h'(x)$.
b) Find $k'(x)$.

The following table lists some of the values of functions $f(x)$, $f'(x)$, $g(x)$ and $g'(x)$.

	$x = 1,$	$x = 0,$	$x = -1,$
$f(x)$	2	0	-1
$f'(x)$	-1	2	4
$g(x)$	-2	1	-3
$g'(x)$	3	-1	2

c) Find $h'(1)$
d) Find $k'(1)$

10) Evaluate the following limits:

a) $\lim_{x\to 0} \frac{\sin^2(8x)}{\tan^2(x)}$
b) $\lim_{\theta\to \pi} \frac{\sin\theta}{\theta+\tan\theta}$
c) $\lim_{\theta\to 0} \frac{\sin\theta}{\theta+\tan\theta}$
d) $\lim_{x\to 1} \frac{\sin(x-1)}{x^2+x-2}$
e) $\lim_{x\to \infty} \frac{\cos(x+1)}{x^2-2x-3}$

11) Derive the derivatives of the following functions (by either using the limit definition or Implicit Differentiation).

a) $f(x) = \frac{x+2}{x}$
b) $g(x) = \sin(x)$
c) $h(x) = \tan^{-1}(x)$

12) Let $f(x) = \tan^{-1}(3x^2)$

a) Find the slope of the normal line to at $x = 1$.
b) Find $f''(0)$.

13) For what values of x does the function $g(x) = x + 2\sin x$ have horizontal tangent lines?

14) Suppose $f(x) = ax^2 + bx + c$ and that the tangent lines at $x = 1$ and $x = -1$ have slopes -8 and -1 respectively, and that the point $(2,15)$ is a point on the graph. What are the values of $a, b,$ and c?

15) Find the values of a so that the tangent line to $y = x^2 - 2\sqrt{x} + 1$ is perpendicular to the line $ay + 2x = 2$ at $x = 4$.

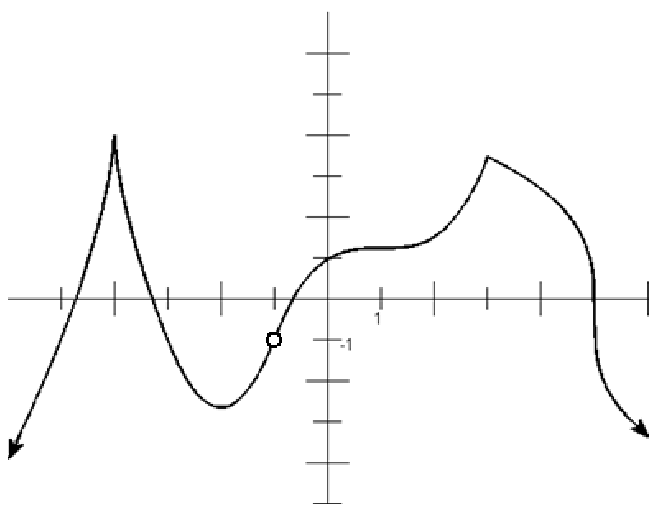
16) The position, in meters, of a particle at time t is given by

$$f(t) = t^3 - 9t^2 + 15t - 12$$

where t is measured in seconds.

a) What is the displacement from 0 to 8 seconds.
b) Find the particles average rate of change from 2 to 4 seconds.
c) Find a function for the velocity at time t.
d) What is the particle's instantaneous rate of change at 2 seconds.
e) At which time(s) is the particle at rest?
f) When is the particle moving in the positive direction?
g) Find a function for the acceleration at time t.

17) Given the graph below:



Identify where the function…

a) ... is increasing,
b) … is decreasing,
c) … has horizontal tangents,
d) …has vertical tangents,
e) … Is not differentiable. Can you classify the types of non-differentiability.
f) Now use the answers above to sketch a graph of the derivative.