1. The slope of a curve at a point (x, y) is defined as $\lim_{h \to 0} \frac{(x+h)^3 + (x+h)^2 - x^3 - x^2}{h}$.

Which of the following is the equation of the line tangent to this curve at $(1, 2)$?

$y' = \lim_{h \to 0} \frac{(x+h)^3 + (x+h)^2 - x^3 - x^2}{h}$ $= \lim_{h \to 0} \frac{\left[(x+h)^3 + (x+h)^2\right] - \left(x^3 + x^2\right)}{h}$ $= \frac{d}{dx}\left[x^3 + x^2\right]$ $= 3x^2 + 2x$	$y'(1) = 3(1)^2 + 2(1)$ $= 5$ $\downarrow$ $y - y_1 = m(x - x_1)$ $y - 2 = 5(x - 1)$ $y - 2 = 5x - 5$ $y = 5x - 3$

(a) $y = 5x - 2$ (b) $y = 3x - 9$ (c) $y = 5x - 3$ (d) $y = 3x - 6$ (e) $y = x - 2$

2. If $f(x) = g(h(x))$ and if $h(2) = 5$, $h'(2) = -5$, and $g'(5) = 3$, which of the following is the value of $f'(2)$?

$$f(x) = g(h(x))$$
$$\downarrow$$
$$f'(x) = g'(h(x)) \cdot h'(x)$$
$$f'(2) = g'(h(2)) \cdot h'(2)$$
$$= g'(5) \cdot (-5)$$
$$= (3) \cdot (-5)$$
$$= -15$$

(a) 3 (b) -15 (c) 15 (d) -3 (e) 18

3. Which of the following is $\frac{dy}{dx}$, the first derivative of $y = f(x)$ if $x^2 y + \sec(y) = 8$?

$$x^2 y + \sec(y) = 8$$
$$\downarrow$$
$$2xy + x^2 \cdot y' + \sec(y)\tan(y)\cdot y' = 0$$
$$x^2 \cdot y' + \sec(y)\tan(y)\cdot y' = -2xy$$
$$y'\left[x^2 + \sec(y)\tan(y)\right] = -2xy$$
$$y' = \frac{-2xy}{x^2 + \sec(y)\tan(y)}$$

(a) $-2xy\left(x^2 \sec(y)\tan(y)\right)$ (b) $\frac{x^2 y}{\sec(y)\tan(y)}$ (c) $\frac{\sec(y)\tan(y)}{-2}$

(d) $\frac{-2xy}{x^2 - \sec(y)\tan(y)}$ (e) $\frac{-2xy}{x^2 + \sec(y)\tan(y)}$

4. Which of the following is the derivative of $\sin^4\left(\cot^3(7x)\right)$?

$$\frac{d}{dx}\left[\sin^4\left(\cot^3(7x)\right)\right] = \frac{d}{dx}\left[\left(\sin\left(\left[\cot(7x)\right]^3\right)\right)^4\right]$$
$$= 4\left(\sin\left(\left[\cot(7x)\right]^3\right)\right)^3 \cdot \cos\left(\left[\cot(7x)\right]^3\right)\cdot 3\left[\cot(7x)\right]^2 \cdot\left(-\csc^2(7x)\right)\cdot 7$$
$$= -84\left(\sin\left(\left[\cot(7x)\right]^3\right)\right)^3 \cos\left(\left[\cot(7x)\right]^3\right)\left[\cot(7x)\right]^2 \csc^2(7x)$$
$$= -84\sin^3\left(\left[\cot(7x)\right]^3\right)\cos\left(\cot^3(7x)\right)\cot^2(7x)\csc^2(7x)$$

(a) $84\sin^3\left(\cot^3(7x)\right)\cot^2(7x)$

(b) $-84\sin^3\left(\cot^3(7x)\right)\cos\left(\cot^3(7x)\right)\csc^2(7x)$

(c) $-84\sin^3\left(\cot^3(7x)\right)\cos\left(\cot^3(7x)\right)\cot^2(7x)\csc^2(7x)$

(d) $12\sin^3\left(\cot^3(7x)\right)\cos\left(\cot^3(7x)\right)\cot^2(7x)\csc^2(7x)$

(e) $-12\sin^3\left(\cot^3(7x)\right)\cos\left(\cot^3(7x)\right)\cot^2(7x)\csc^2(7x)$

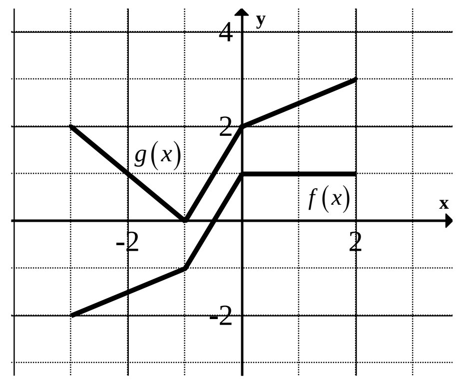
5. $\lim_{h\to 0}\frac{\cot(3(x+h))-\cot(3x)}{h}=$

$$\lim_{h\to 0}\frac{\cot(3(x+h))-\cot(3x)}{h}=\frac{d}{dx}\left[\cot(3x)\right]$$
$$=-\csc^2(3x)\cdot 3$$
$$=-3\csc^2(3x)$$

(a) $-\csc^2(3x)$ (b) $-3\csc(3x)\cot(3x)$ (c) $\csc(3x)\cot(3x)$

(d) $-3\csc^2(3x)$ (e) $3\sec^2(3x)$

6. Let $f(x)$ and $g(x)$ be the piecewise linear functions whose graphs are shown below. If $h(x)=\frac{f(x)}{g(x)}$, then what is the value of $h'(-2)$?



$$h(x)=\frac{f(x)}{g(x)}$$
$$\downarrow$$
$$h'(x)=\frac{f'(x)g(x)-f(x)g'(x)}{\left[g(x)\right]^2}$$
$$h'(-2)=\frac{f'(-2)g(-2)-f(-2)g'(-2)}{\left[g(-2)\right]^2}$$
$$=\frac{\left(\frac{1}{2}\right)(1)-\left(-\frac{3}{2}\right)(-1)}{[1]^2}$$
$$=-1$$

(a) $-\frac{3}{2}$ (b) -1 (c) $-\frac{1}{2}$ (d) 1 (e) $\frac{3}{2}$

7. What is the derivative of $y=\dfrac{4x^2-3x+7}{5x}$?

$$
\begin{aligned}
y &= \frac{4x^2-3x+7}{5x}\\
&\downarrow\\
y' &= \frac{(8x-3)(5x)-\left(4x^2-3x+7\right)(5)}{[5x]^2}\\
&= \frac{\left(40x^2-15x\right)-\left(20x^2-15x+35\right)}{25x^2}\\
&= \frac{20x^2-35}{25x^2}\\
&= \frac{4x^2-7}{5x^2}
\end{aligned}
$$

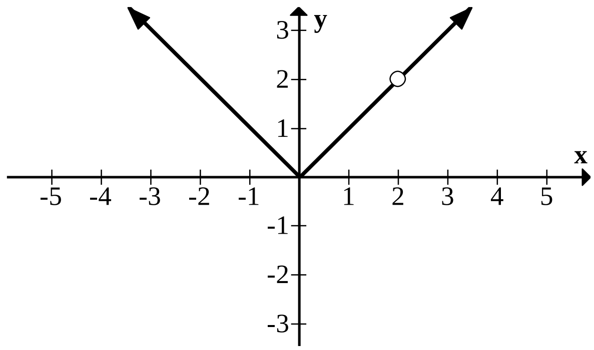
(a) $\dfrac{4x^2+7}{25x^2}$ (b) $\dfrac{4x^2-7}{5x^2}$ (c) $\dfrac{7-4x^2}{5x^2}$ (d) $\dfrac{8x-3}{5}$ (e) $\dfrac{4x-8}{25x}$

8. If $f(x)=\sqrt{6\sin(x)+9}$, then the derivative of f at $x=0$ is

$$
\begin{aligned}
f(x) &= \sqrt{6\sin(x)+9}\\
&= \left(6\sin(x)+9\right)^{\frac{1}{2}}\\
&\downarrow\\
f'(x) &= \frac{1}{2}\left(6\sin(x)+9\right)^{-\frac{1}{2}}\cdot\left(6\cos(x)\right)\\
&= \frac{3\cos(x)}{\sqrt{6\sin(x)+9}}\\
f'(0) &= \frac{3\cos(0)}{\sqrt{6\sin(0)+9}}\\
&= \frac{3}{3}\\
&= 1
\end{aligned}
$$

(a) $\dfrac{1}{2\sqrt{3}}$ (b) 0 (c) 1 (d) $\dfrac{\sqrt{3}}{6}$ (e) $\sqrt{3}$

9. If $f'(a)$ does NOT exist, which of the following MUST be true?



(a) $f(x)$ is discontinuous at $x = a$

(b) $\lim_{x \to a} f(x)$ does not exist

(c) f has a vertical tangent at $x = a$

(d) f has a "hole"/removable discontinuity at $x = a$

(e) None of the above are necessarily true

10. Given that *j*, *k*, and *m* are constants, and $f(x) = m - 2kx$, what is $f'(j) =$?

$$f(x) = m - 2kx$$
$$\downarrow$$
$$f'(x) = -2k$$

(a) m (b) $m - 2jk$ (c) $-2jk$ (d) $-2k$ (e) j

11. If $y = 2\sqrt{x} - \dfrac{1}{2\sqrt{x}}$, then the derivative of y with respect to x is given by

$$y = 2\sqrt{x} - \frac{1}{2\sqrt{x}}$$
$$= 2x^{\frac{1}{2}} - \frac{1}{2}x^{-\frac{1}{2}}$$
$$\downarrow$$
$$y' = x^{-\frac{1}{2}} + \frac{1}{4}x^{-\frac{3}{2}}$$
$$= \frac{1}{\sqrt{x}} + \frac{1}{4\sqrt{x^3}}$$
$$= \frac{1}{\sqrt{x}} + \frac{1}{4\sqrt{x^2 \cdot x}}$$
$$= \frac{1}{\sqrt{x}} + \frac{1}{4x\sqrt{x}}$$

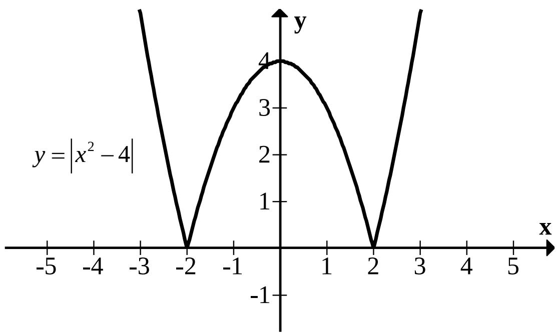
(a) $x + \dfrac{1}{x\sqrt{x}}$ (b) $\dfrac{1}{\sqrt{x}} + \dfrac{1}{x\sqrt{x}}$ (c) $\dfrac{4x-1}{4x\sqrt{x}}$ (d) $\dfrac{1}{\sqrt{x}} + \dfrac{1}{4x\sqrt{x}}$ (e) $\dfrac{4}{\sqrt{x}} + \dfrac{1}{x\sqrt{x}}$

12. If $y=\dfrac{x-3}{2-5x}$, then $\dfrac{dy}{dx}=$

$$y=\frac{x-3}{2-5x}$$
$$\downarrow$$
$$y'=\frac{(1)(2-5x)-(x-3)(-5)}{(2-5x)^2}$$
$$=\frac{2-5x-(-5x+15)}{(2-5x)^2}$$
$$=\frac{-13}{(2-5x)^2}$$

(a) $\dfrac{17-10x}{(2-5x)^2}$ (b) $\dfrac{13}{(2-5x)^2}$ (c) $\dfrac{x-3}{(2-5x)^2}$ (d) $\dfrac{17}{(2-5x)^2}$ (e) $\dfrac{-13}{(2-5x)^2}$

13. $\dfrac{d}{dx}\left[|g(x)|\right]=\dfrac{g(x)}{|g(x)|}\cdot g'(x)$. The function $f(x)=|x^2-4|$ is NOT differentiable at



$$f(x)=|x^2-4|$$
$$\downarrow$$
$$f'(x)=\frac{x^2-4}{|x^2-4|}\cdot 2x \qquad f'(x)\text{ DNE when } x=\pm 2$$
$$=\frac{2x(x^2-4)}{|(x-2)(x+2)|}$$

(a) $x=2$ only (b) $x=-2$ only (c) $x=-2$ or $x=2$ only
(d) $x=0$ only (e) $x=2$ or $x=-2$ or $x=0$