

1. Differentiate the following function:  $f(x) = \frac{3}{\sqrt[3]{x}} + \frac{-1}{x^4} - 2x^2$
2. Differentiate the following function:  $f(x) = -3\sqrt[3]{x^{13}} + 3x^3 + \frac{-4}{x}$
3. Differentiate the following function:  $f(x) = -3\sqrt[3]{x^{10}} - 5x^{10} + \frac{4}{x^6}$
4. Differentiate the following function:  $f(x) = 4x^{13} + \frac{5}{\sqrt[3]{x^{11}}} + \frac{-1}{x^4}$
5. Differentiate the following function:  $f(x) = 2\sqrt[3]{x^7} + 4\sqrt[3]{x^4} + \frac{-3}{\sqrt[3]{x^{11}}}$
6. Differentiate the following function:  $f(x) = 4\sqrt[2]{x^{13}} - 4\sqrt[2]{x^{11}} + \frac{-2}{x^{12}}$
7. Differentiate the following function:  $f(x) = \frac{2}{\sqrt[2]{x^{15}}} + \sqrt[3]{x^8} + \frac{-2}{\sqrt[2]{x^3}}$
8. Differentiate the following function:  $f(x) = \frac{-5}{x^{10}} + 4x^{15} + \frac{-2}{x^6}$
9. Differentiate the following function:  $f(x) = \frac{4}{\sqrt[2]{x^5}} + \frac{-3}{\sqrt[2]{x^3}} + \frac{2}{x^6}$
10. Differentiate the following function:  $f(x) = \frac{3}{x^4} + \frac{3}{x^4} + \frac{1}{x^5}$

- Answers:
1.  $-\frac{3}{4}x^{-\frac{4}{3}} - \frac{4}{x^5} - 4x$
  2.  $-x^{-\frac{10}{3}} + 9x^2 - \frac{4}{x^2}$
  3.  $-x^{-\frac{7}{3}} - 50x^9 + \frac{4}{x^7}$
  4.  $4x^{12} - \frac{5}{3}x^{-\frac{12}{11}} - \frac{1}{x^5}$
  5.  $\frac{2}{3}x^{-\frac{2}{3}} + \frac{4}{3}x^{-\frac{2}{3}} - \frac{3}{2}x^{-\frac{14}{3}}$
  6.  $2x^{11} - 2x^9 - \frac{2}{x^{13}}$
  7.  $-\frac{2}{3}x^{-\frac{16}{15}} + \frac{8}{3}x^5 - \frac{2}{3}x^{-\frac{5}{6}}$
  8.  $-\frac{5}{10}x^{-11} + 60x^{14} - \frac{2}{6}x^{-7}$
  9.  $\frac{4}{5}x^{-\frac{7}{5}} - \frac{3}{2}x^{-\frac{5}{2}} + \frac{2}{x^7}$
  10.  $-\frac{3}{x^5} - \frac{3}{x^5} - \frac{1}{x^6}$

Solutions:

$$\begin{aligned}
1. \quad f'(x) &= \frac{d}{dx} f(x) = \frac{d}{dx} \left[ \frac{3}{\sqrt[3]{x}} + \frac{-1}{x^4} - 2x^2 \right] && \blacktriangleright \text{ Use the sum/difference rules: } && \frac{d}{dx} [f(x) + g(x)] = \\
& \frac{d}{dx} f(x) + \frac{d}{dx} g(x) && \frac{d}{dx} [f(x) - g(x)] = \frac{d}{dx} f(x) - \frac{d}{dx} g(x) \\
&= \frac{d}{dx} \left[ \frac{3}{\sqrt[3]{x}} \right] + \frac{d}{dx} \left[ \frac{-1}{x^4} \right] + \frac{d}{dx} [-2x^2] && \blacktriangleright \text{ Use the power notation:} \\
&= \frac{d}{dx} \left[ 3x^{-\frac{1}{3}} \right] + \frac{d}{dx} [-1x^{-4}] + \frac{d}{dx} [-2x^2] && \blacktriangleright \text{ Apply: } && \frac{d}{dx} cf(x) = c \frac{d}{dx} f(x) && \frac{d}{dx} x^n = nx^{n-1} \\
&= (3) \frac{-1}{3} x^{-\frac{1}{3}-1} + (-1)(-4)x^{-4-1} + (-2)(2)x^{2-1} && \blacktriangleright \text{ Simplify:} \\
&= \frac{-1}{1} x^{-\frac{4}{3}} + 4x^{-5} - 4x^1 && \blacktriangleright \text{ Write the result in standard form:} \\
&= \frac{-1}{\sqrt[3]{x^4}} + \frac{4}{x^5} - 4x
\end{aligned}$$

$$\begin{aligned}
2. \quad f'(x) &= \frac{d}{dx} f(x) = \frac{d}{dx} \left[ -3\sqrt[3]{x^{13}} + 3x^3 + \frac{-4}{x} \right] && \blacktriangleright \text{ Use the sum/difference rules: } && \frac{d}{dx} [f(x) + g(x)] = \\
& \frac{d}{dx} f(x) + \frac{d}{dx} g(x) && \frac{d}{dx} [f(x) - g(x)] = \frac{d}{dx} f(x) - \frac{d}{dx} g(x) \\
&= \frac{d}{dx} \left[ -3\sqrt[3]{x^{13}} \right] + \frac{d}{dx} [3x^3] + \frac{d}{dx} \left[ \frac{-4}{x} \right] && \blacktriangleright \text{ Use the power notation:} \\
&= \frac{d}{dx} \left[ -3x^{\frac{13}{3}} \right] + \frac{d}{dx} [3x^3] + \frac{d}{dx} [-4x^{-1}] && \blacktriangleright \text{ Apply: } && \frac{d}{dx} cf(x) = c \frac{d}{dx} f(x) && \frac{d}{dx} x^n = nx^{n-1} \\
&= (-3) \frac{13}{3} x^{\frac{13}{3}-1} + (3)(3)x^{3-1} + (-4)(-1)x^{-1-1} && \blacktriangleright \text{ Simplify:} \\
&= \frac{-13}{1} x^{\frac{10}{3}} + 9x^2 + 4x^{-2} && \blacktriangleright \text{ Write the result in standard form:} \\
&= -13\sqrt[3]{x^{10}} + 9x^2 + \frac{4}{x^2}
\end{aligned}$$

$$\begin{aligned}
3. \quad f'(x) &= \frac{d}{dx} f(x) = \frac{d}{dx} \left[ -3\sqrt[3]{x^{10}} - 5x^{10} + \frac{4}{x^6} \right] && \blacktriangleright \text{ Use the sum/difference rules: } && \frac{d}{dx} [f(x) + g(x)] = \\
& \frac{d}{dx} f(x) + \frac{d}{dx} g(x) && \frac{d}{dx} [f(x) - g(x)] = \frac{d}{dx} f(x) - \frac{d}{dx} g(x) \\
&= \frac{d}{dx} \left[ -3\sqrt[3]{x^{10}} \right] + \frac{d}{dx} [-5x^{10}] + \frac{d}{dx} \left[ \frac{4}{x^6} \right] && \blacktriangleright \text{ Use the power notation:} \\
&= \frac{d}{dx} \left[ -3x^{\frac{10}{3}} \right] + \frac{d}{dx} [-5x^{10}] + \frac{d}{dx} [4x^{-6}] && \blacktriangleright \text{ Apply: } && \frac{d}{dx} cf(x) = c \frac{d}{dx} f(x) && \frac{d}{dx} x^n = nx^{n-1} \\
&= (-3) \frac{10}{3} x^{\frac{10}{3}-1} + (-5)(10)x^{10-1} + (4)(-6)x^{-6-1} && \blacktriangleright \text{ Simplify:} \\
&= \frac{-10}{1} x^{\frac{7}{3}} - 50x^9 - 24x^{-7} && \blacktriangleright \text{ Write the result in standard form:} \\
&= -10\sqrt[3]{x^7} - 50x^9 + \frac{-24}{x^7}
\end{aligned}$$

$$\begin{aligned}
4. \quad f'(x) &= \frac{d}{dx} f(x) = \frac{d}{dx} \left[ 4x^{13} + \frac{5}{\sqrt[3]{x^{11}}} + \frac{-1}{x^4} \right] && \blacktriangleright \text{ Use the sum/difference rules: } && \frac{d}{dx} [f(x) + g(x)] = \\
& \frac{d}{dx} f(x) + \frac{d}{dx} g(x) && \frac{d}{dx} [f(x) - g(x)] = \frac{d}{dx} f(x) - \frac{d}{dx} g(x)
\end{aligned}$$

$$\begin{aligned}
 &= \frac{d}{dx} [4x^{13}] + \frac{d}{dx} \left[ \frac{5}{\sqrt[3]{x^{11}}} \right] + \frac{d}{dx} \left[ \frac{-1}{x^4} \right] && \blacktriangleright \text{Use the power notation:} \\
 &= \frac{d}{dx} [4x^{13}] + \frac{d}{dx} \left[ 5x^{\frac{-11}{3}} \right] + \frac{d}{dx} [-1x^{-4}] && \blacktriangleright \text{Apply: } \frac{d}{dx} cf(x) = c \frac{d}{dx} f(x) \quad \frac{d}{dx} x^n = nx^{n-1} \\
 &= (4)(13)x^{13-1} + (5) \frac{-11}{3} x^{\frac{-11}{3}-1} + (-1)(-4)x^{-4-1} && \blacktriangleright \text{Simplify:} \\
 &= 52x^{12} + \frac{-55}{3} x^{\frac{-14}{3}} + 4x^{-5} && \blacktriangleright \text{Write the result in standard form:} \\
 &= 52x^{12} + \frac{-55}{3\sqrt[3]{x^{14}}} + \frac{4}{x^5}
 \end{aligned}$$

$$\begin{aligned}
 5. \quad f'(x) &= \frac{d}{dx} f(x) = \frac{d}{dx} \left[ 2\sqrt[3]{x^7} + 4\sqrt[3]{x^4} + \frac{-3}{\sqrt[3]{x^{11}}} \right] && \blacktriangleright \text{Use the sum/difference rules: } \frac{d}{dx} [f(x) + \\
 g(x)] &= \frac{d}{dx} f(x) + \frac{d}{dx} g(x) \quad \frac{d}{dx} [f(x) - g(x)] = \frac{d}{dx} f(x) - \frac{d}{dx} g(x) \\
 &= \frac{d}{dx} [2\sqrt[3]{x^7}] + \frac{d}{dx} [4\sqrt[3]{x^4}] + \frac{d}{dx} \left[ \frac{-3}{\sqrt[3]{x^{11}}} \right] && \blacktriangleright \text{Use the power notation:} \\
 &= \frac{d}{dx} [2x^{\frac{7}{3}}] + \frac{d}{dx} [4x^{\frac{4}{3}}] + \frac{d}{dx} [-3x^{\frac{-11}{3}}] && \blacktriangleright \text{Apply: } \frac{d}{dx} cf(x) = c \frac{d}{dx} f(x) \quad \frac{d}{dx} x^n = nx^{n-1} \\
 &= (2) \frac{7}{3} x^{\frac{7}{3}-1} + (4) \frac{4}{3} x^{\frac{4}{3}-1} + (-3) \frac{-11}{3} x^{\frac{-11}{3}-1} && \blacktriangleright \text{Simplify:} \\
 &= \frac{14}{3} x^{\frac{4}{3}} + \frac{16}{3} x^{\frac{1}{3}} + \frac{11}{1} x^{\frac{-14}{3}} && \blacktriangleright \text{Write the result in standard form:} \\
 &= \frac{14\sqrt[3]{x^4}}{3} + \frac{16\sqrt[3]{x}}{3} + \frac{11}{\sqrt[3]{x^{14}}}
 \end{aligned}$$

$$\begin{aligned}
 6. \quad f'(x) &= \frac{d}{dx} f(x) = \frac{d}{dx} \left[ 4\sqrt[2]{x^{13}} - 4\sqrt[2]{x^{11}} + \frac{-2}{x^{12}} \right] && \blacktriangleright \text{Use the sum/difference rules: } \frac{d}{dx} [f(x) + \\
 g(x)] &= \frac{d}{dx} f(x) + \frac{d}{dx} g(x) \quad \frac{d}{dx} [f(x) - g(x)] = \frac{d}{dx} f(x) - \frac{d}{dx} g(x) \\
 &= \frac{d}{dx} [4\sqrt[2]{x^{13}}] + \frac{d}{dx} [-4\sqrt[2]{x^{11}}] + \frac{d}{dx} \left[ \frac{-2}{x^{12}} \right] && \blacktriangleright \text{Use the power notation:} \\
 &= \frac{d}{dx} [4x^{\frac{13}{2}}] + \frac{d}{dx} [-4x^{\frac{11}{2}}] + \frac{d}{dx} [-2x^{-12}] && \blacktriangleright \text{Apply: } \frac{d}{dx} cf(x) = c \frac{d}{dx} f(x) \quad \frac{d}{dx} x^n = nx^{n-1} \\
 &= (4) \frac{13}{2} x^{\frac{13}{2}-1} + (-4) \frac{11}{2} x^{\frac{11}{2}-1} + (-2)(-12)x^{-12-1} && \blacktriangleright \text{Simplify:} \\
 &= \frac{26}{1} x^{\frac{11}{2}} + \frac{-22}{1} x^{\frac{9}{2}} + 24x^{-13} && \blacktriangleright \text{Write the result in standard form:} \\
 &= 26\sqrt[2]{x^{11}} - 22\sqrt[2]{x^9} + \frac{24}{x^{13}}
 \end{aligned}$$

$$\begin{aligned}
 7. \quad f'(x) &= \frac{d}{dx} f(x) = \frac{d}{dx} \left[ \frac{2}{\sqrt[2]{x^{15}}} + \sqrt[3]{x^8} + \frac{-2}{\sqrt[2]{x^3}} \right] && \blacktriangleright \text{Use the sum/difference rules: } \frac{d}{dx} [f(x) + g(x)] = \\
 \frac{d}{dx} f(x) + \frac{d}{dx} g(x) &\quad \frac{d}{dx} [f(x) - g(x)] = \frac{d}{dx} f(x) - \frac{d}{dx} g(x) \\
 &= \frac{d}{dx} \left[ \frac{2}{\sqrt[2]{x^{15}}} \right] + \frac{d}{dx} [\sqrt[3]{x^8}] + \frac{d}{dx} \left[ \frac{-2}{\sqrt[2]{x^3}} \right] && \blacktriangleright \text{Use the power notation:} \\
 &= \frac{d}{dx} [2x^{\frac{-15}{2}}] + \frac{d}{dx} [1x^{\frac{8}{3}}] + \frac{d}{dx} [-2x^{\frac{-3}{2}}] && \blacktriangleright \text{Apply: } \frac{d}{dx} cf(x) = c \frac{d}{dx} f(x) \quad \frac{d}{dx} x^n = nx^{n-1}
 \end{aligned}$$

$$= (2)\frac{-15}{2}x^{\frac{-15}{2}-1} + (1)\frac{8}{3}x^{\frac{8}{3}-1} + (-2)\frac{-3}{2}x^{\frac{-3}{2}-1} \quad \blacktriangleright \text{Simplify:}$$

$$= \frac{-15}{1}x^{\frac{-17}{2}} + \frac{8}{3}x^{\frac{5}{3}} + \frac{3}{1}x^{\frac{-5}{2}} \quad \blacktriangleright \text{Write the result in standard form:}$$

$$= \frac{-15}{\sqrt[2]{x^{17}}} + \frac{8\sqrt[3]{x^5}}{3} + \frac{3}{\sqrt[2]{x^5}}$$

$$8. f'(x) = \frac{d}{dx}f(x) = \frac{d}{dx}\left[\frac{-5}{x^{10}} + 4x^{15} + \frac{-2}{x^6}\right] \quad \blacktriangleright \text{Use the sum/difference rules:} \quad \frac{d}{dx}[f(x) + g(x)] =$$

$$\frac{d}{dx}f(x) + \frac{d}{dx}g(x) \quad \frac{d}{dx}[f(x) - g(x)] = \frac{d}{dx}f(x) - \frac{d}{dx}g(x)$$

$$= \frac{d}{dx}\left[\frac{-5}{x^{10}}\right] + \frac{d}{dx}[4x^{15}] + \frac{d}{dx}\left[\frac{-2}{x^6}\right] \quad \blacktriangleright \text{Use the power notation:}$$

$$= \frac{d}{dx}[-5x^{-10}] + \frac{d}{dx}[4x^{15}] + \frac{d}{dx}[-2x^{-6}] \quad \blacktriangleright \text{Apply:} \quad \frac{d}{dx}cf(x) = c\frac{d}{dx}f(x) \quad \frac{d}{dx}x^n = nx^{n-1}$$

$$= (-5)(-10)x^{-10-1} + (4)(15)x^{15-1} + (-2)(-6)x^{-6-1} \quad \blacktriangleright \text{Simplify:}$$

$$= 50x^{-11} + 60x^{14} + 12x^{-7} \quad \blacktriangleright \text{Write the result in standard form:}$$

$$= \frac{50}{x^{11}} + 60x^{14} + \frac{12}{x^7}$$

$$9. f'(x) = \frac{d}{dx}f(x) = \frac{d}{dx}\left[\frac{4}{\sqrt[2]{x^5}} + \frac{-3}{\sqrt[2]{x^3}} + \frac{2}{x^6}\right] \quad \blacktriangleright \text{Use the sum/difference rules:} \quad \frac{d}{dx}[f(x) + g(x)] =$$

$$\frac{d}{dx}f(x) + \frac{d}{dx}g(x) \quad \frac{d}{dx}[f(x) - g(x)] = \frac{d}{dx}f(x) - \frac{d}{dx}g(x)$$

$$= \frac{d}{dx}\left[\frac{4}{\sqrt[2]{x^5}}\right] + \frac{d}{dx}\left[\frac{-3}{\sqrt[2]{x^3}}\right] + \frac{d}{dx}\left[\frac{2}{x^6}\right] \quad \blacktriangleright \text{Use the power notation:}$$

$$= \frac{d}{dx}[4x^{\frac{-5}{2}}] + \frac{d}{dx}[-3x^{\frac{-3}{2}}] + \frac{d}{dx}[2x^{-6}] \quad \blacktriangleright \text{Apply:} \quad \frac{d}{dx}cf(x) = c\frac{d}{dx}f(x) \quad \frac{d}{dx}x^n = nx^{n-1}$$

$$= (4)\frac{-5}{2}x^{\frac{-5}{2}-1} + (-3)\frac{-3}{2}x^{\frac{-3}{2}-1} + (2)(-6)x^{-6-1} \quad \blacktriangleright \text{Simplify:}$$

$$= \frac{-10}{1}x^{\frac{-7}{2}} + \frac{9}{2}x^{\frac{-5}{2}} - 12x^{-7} \quad \blacktriangleright \text{Write the result in standard form:}$$

$$= \frac{-10}{\sqrt[2]{x^7}} + \frac{9}{2\sqrt[2]{x^5}} + \frac{-12}{x^7}$$

$$10. f'(x) = \frac{d}{dx}f(x) = \frac{d}{dx}\left[\frac{3}{x^4} + \frac{3}{x^4} + \frac{1}{x^5}\right] \quad \blacktriangleright \text{Use the sum/difference rules:} \quad \frac{d}{dx}[f(x) + g(x)] =$$

$$\frac{d}{dx}f(x) + \frac{d}{dx}g(x) \quad \frac{d}{dx}[f(x) - g(x)] = \frac{d}{dx}f(x) - \frac{d}{dx}g(x)$$

$$= \frac{d}{dx}\left[\frac{3}{x^4}\right] + \frac{d}{dx}\left[\frac{3}{x^4}\right] + \frac{d}{dx}\left[\frac{1}{x^5}\right] \quad \blacktriangleright \text{Use the power notation:}$$

$$= \frac{d}{dx}[3x^{-4}] + \frac{d}{dx}[3x^{-4}] + \frac{d}{dx}[1x^{-5}] \quad \blacktriangleright \text{Apply:} \quad \frac{d}{dx}cf(x) = c\frac{d}{dx}f(x) \quad \frac{d}{dx}x^n = nx^{n-1}$$

$$= (3)(-4)x^{-4-1} + (3)(-4)x^{-4-1} + (1)(-5)x^{-5-1} \quad \blacktriangleright \text{Simplify:}$$

$$= -12x^{-5} - 12x^{-5} - 5x^{-6} \quad \blacktriangleright \text{Write the result in standard form:}$$

$$= \frac{-12}{x^5} + \frac{-12}{x^5} + \frac{-5}{x^6}$$