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# Workbook

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# Differentiability

## Differentiability

### Questions:

**1)** Determine points of non-differentiability of the following functions, and find $f'(2)$, if possible.

a. $f(x)=\begin{cases}x^2-4x & x\geq 2\\ x^3-14 & x<2\end{cases}$

b. $f(x)=\begin{cases}x^2-5x & x\geq 2\\ x^3-14 & x<2\end{cases}$

c. $f(x)=\begin{cases}x^2+8x & x\geq 2\\ x^3+12 & x<2\end{cases}$

**2)** Determine points of non-differentiability of the following functions, and write the formula for $f'(x)$:

a. $f(x)=\begin{cases}\ln(1+2x) & -0.5<x<0\\ x^2+2x & x\geq 0\end{cases}$

b. $f(x)=2+4|x-1|$

c. $f(x)=3x^2+x|x|+1$

**3)** Determine points of non-differentiability of the following functions, and find $f'(0)$ if possible:

a. $f(x)=\begin{cases}x\cdot\sin\frac{1}{x} & x>0\\ 0 & x\leq 0\end{cases}$

b. $f(x)=\begin{cases}x^2\cdot\sin\frac{1}{x} & x>0\\ 0 & x\leq 0\end{cases}$

**4)** For what value or values of the constants $a$ and $b$, is $f$ differentiable for all values of $x$:

a. $f(x)=\begin{cases}x^2+ax & x\geq 2\\ x^3+b & x<2\end{cases}$

b. $f(x)=\begin{cases}e^x & x\leq 0\\ ax+b & x>0\end{cases}$

c. $f(x)=\begin{cases}\ln^3 x & x\geq e\\ ax+b & x<e\end{cases}$


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## Answer Key:

**1)** a. $x=2$ b. $x=2$ c. $f(x)$ is differentiable for all $x$.

**2)** a. $f'(x)=\begin{cases}\dfrac{2}{1+2x} & -0.5<x<0\\ 2 & x=0\\ 2x+2 & x>0\end{cases}$ b. $x=1$

c. $f(x)$ is differentiable for all $x$, $f'(x)=\begin{cases}8x & x>0\\ 0 & x=0\\ 4x & x<0\end{cases}$.

**3)** a. $f'(x)=\begin{cases}\sin\dfrac{1}{x}-\dfrac{1}{x^2}x\cos\dfrac{1}{x} & x>0\\ \text{not exist} & x=0\\ 0 & x<0\end{cases}$ b. $f'(x)=\begin{cases}2x\sin\dfrac{1}{x}-\cos\dfrac{1}{x} & x>0\\ 0 & x=0\\ 0 & x<0\end{cases}$.

**4)** a. $a=8$, $b=12$ b. $b=1$ c. $a=\dfrac{3}{e}$, $b=-2$.


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