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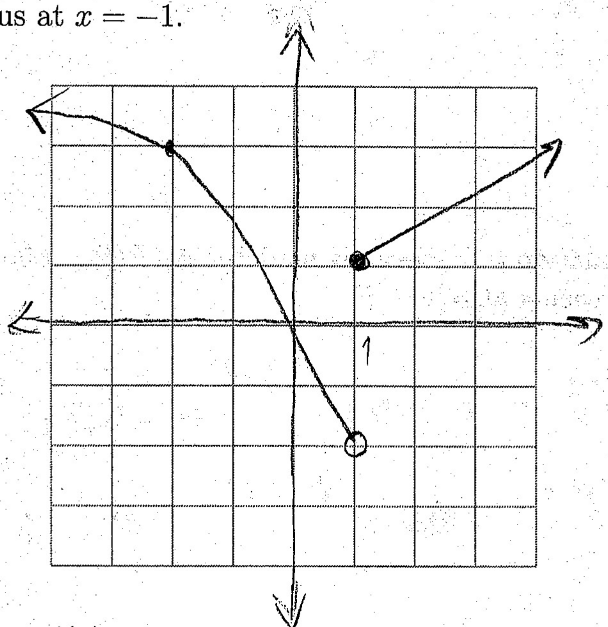
1. On the grid below, sketch a graph of a function $f(x)$ which has the following properties. Note: many answers are possible; there is not just one correct answer.
   (a) There is an essential discontinuity at $x = 1$.
   (b) $\lim_{x \to 1^-} f(x) = -2$.
   (c) $f(-2) = 3$.
   (d) $f(x)$ is continuous at $x = -1$.



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2. If $h(x) = e^x \sin(x)$, find $h'(x)$.

$f(x) = e^x$ $\quad f'(x) = e^x$

$g(x) = \sin(x)$ $\quad g'(x) = \cos(x)$

$f(x)g'(x) + g(x)f'(x) = e^x \cdot \cos(x) + \sin(x) \cdot e^x$

$= e^x \cos(x) + e^x \sin(x)$

3. If $h(x) = x^4 \ln(x)$, find $h'(x)$.

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$f(x) = x^4$ $\quad f'(x) = 4x^3$

$g(x) = \ln(x)$ $\quad g'(x) = \frac{1}{x}$

$f(x)g'(x) + g(x)f'(x) = x^4 \cdot \frac{1}{x} + \ln(x) \cdot 4x^3$

$= x^3 + 4x^3 \ln(x)$

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4. Suppose a function $f(x)$ is defined on all real numbers. You are given that there is an essential discontinuity at $x = 2$. Describe this feature of the graph using appropriate limit notation.

$$\lim_{x \to 2^-} f(x) \neq \lim_{x \to 2^+} f(x)$$

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5. Suppose a population of bacteria is modeled by $P(t) = 6000e^{0.01t}$. At what rate is the population increasing at 5 hours?

$$P'(t) = 6000\, e^{0.01t} = 60\, e^{0.01t}$$

$$P'(5) = 60\, e^{0.01(5)} \approx 63.07$$

Increasing at 64 bacteria/hr.

6. We see from the graph of $y = \ln(x)$ that this function is concave down on its domain. Show this using calculus.

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See text.