**Question 1:** Evaluate the following limits, if they exist. If a limit does not exist because it is $+\infty$ or $-\infty$, state which with an explanation of your reasoning. (Do not use L'Hospital's rule to evaluate limits.)

**(a)** $\displaystyle\lim_{x\to 2^-} \frac{x^2+x-6}{|x-2|}$

**[2]**

**(b)** $\displaystyle\lim_{x\to -3^-} \frac{x+2}{\sin(x+3)}$

**[2]**

**(c)** $\displaystyle\lim_{x\to -\infty} \frac{x-2x^5}{2x^2+x^5}$

**[3]**

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**Question 2:** Determine the value of $k$ which makes the following function continuous at all real numbers:

$$f(x) = \begin{cases} x^2 & \text{if } x \leq -1 \\ k - x^3 & \text{if } x > -1 \end{cases}$$

**[3]**

**Question 3:**

**(a)** Use the limit definition of the derivative to find $f'(x)$ if $f(x) = \dfrac{x}{x+1}$ . Neatly show all steps and use proper notation. (No credit will be given if $f'(x)$ is found using derivative rules.)

**[5]**

**(b)** At what value(s) of $x$ will $f$ fail to be differentiable?

**[2]**

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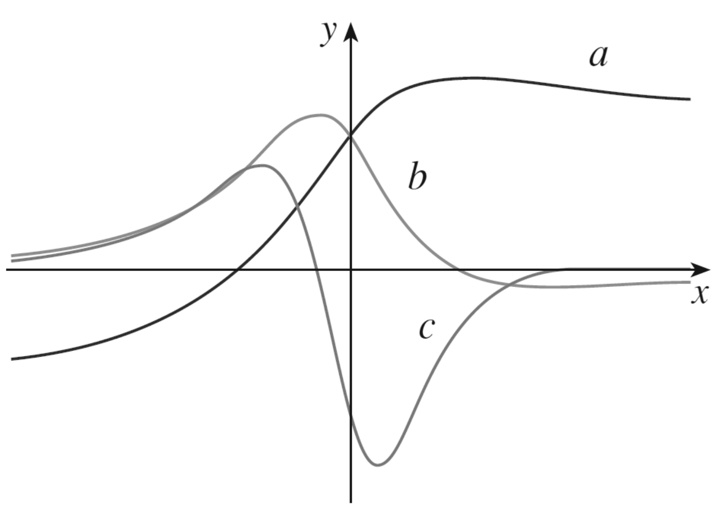
**Question 4:** The figure below shows the graphs of $f$, $f'$ and $f''$. Identify each by circling the appropriate label.




$f$ is graph (circle one): $a$ $b$ $c$

$f'$ is graph (circle one): $a$ $b$ $c$

$f''$ is graph (circle one): $a$ $b$ $c$

**[3]**

**Question 5:** Find the following derivatives (it is not necessary to simplify your answers, but marks will be deducted for improper use of notation):

**(a)** $f(x) = 4\sqrt{x} - \dfrac{5}{x}$

**[2]**

**(b)** $y = \sec(t)(1 - t^3)$

**[3]**

**(c)** $g(x) = \dfrac{\sin(x)}{1 + x - 3\cos(x)}$

**[3]**

**(d)** $y = \dfrac{t^2 \tan(t) - 1}{\pi^2}$

**[2]**

**Question 6:** Find the following derivatives (it is not necessary to simplify your answers, but marks will be deducted for improper use of notation):

**(a)** $y = (1 + x^{2/3})^{3/2}$

**[2]**

**(b)** $y = \dfrac{1}{2 + \sqrt{3t + 4}}$

**[2]**

**(c)** $g(x) = \tan(x \sin(x))$

**[3]**

**(d)** $y = \sqrt[5]{\dfrac{\csc(t)}{t}}$

**[3]**

**Question 7:** There are two tangent lines to the parabola $y = 2x^2$ that pass through the point $(0, -1)$ (sketch the parabola and tangent lines to see this.) For each of these tangent lines, determine the $x$-coordinate of the point where the line meet the parabola.

**[5]**

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**Question 8:** Find an equation of the tangent line to the curve defined by $x + 2y + 1 = \dfrac{y^2}{x-1}$ at the point $(x, y) = (2, -1)$.

**[5]**