

ID number: _____

Name: _____

Put your name on all pages of the test NOW. They will be collected separately.
Give your answers clearly in the space provided. Show work! Point total = 80.

1. RULES OF DIFFERENTIATION. (30 POINTS)

This section will be collected after 20 minutes. Until then you may **NOT** use a calculator. Using rules of differentiation, find the derivatives of each of the following functions.

Simplify where possible.

$$(1) f(x) = \frac{x^5}{7} + \frac{4}{x^3} + 5^x, \quad f'(x) = \quad (4 \text{ points})$$

$$(2) g(t) = \frac{\sin(3t)}{1 + \cos(3t)}, \quad g'(t) = \quad (6 \text{ points})$$

$$(3) h(u) = e^{-6u} \tan(u), \quad h'(u) = \quad (6 \text{ points})$$

$$(4) p(v) = \ln(\sqrt{v}) + v \ln(v^2), \quad p'(v) = \quad (4 \text{ points})$$

$$(5) Q(x) = \arctan(3/x), \quad Q'(x) = \quad (5 \text{ points})$$

$$(6) R(t) = \frac{t^3 + 3}{t^2 + 2}, \quad R'(t) = \quad (5 \text{ points})$$

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2. MEANING AND USE OF DERIVATIVES. (50 POINTS)

Put all answers in the blanks provided. **SHOW ALL WORK!**

- (1) (10 points) Let $f(x) = 5x^2 + (1/x)$. Using the **DEFINITION** of the derivative, find $f'(x)$. Show your work in complete and careful detail. Your work is your answer. No credit for f' without the work.

$$f'(x) =$$

- (2) (8 points) Find the equation of the tangent line to the graph of $y = \sqrt[3]{x}$ at the point where $x = 1000$. Answer: _____

- (3) (3 points) **Using your previous result**, find a better approximation than 10 to $\sqrt[3]{1006}$: _____ (Note: of course you can undoubtedly find a better approximation with your calculator, but don't give me that. However, you could privately use the calculator value to check the reasonableness of your answer.)

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- (4) (7 points) The voltage across a capacitor at time t seconds is $E(t) = 0.01(1 - e^{-3t})$ volts. Give the rate of change of the voltage, with units, at $t = 2$ seconds.

The rate is: _____

- (5) (8 points) A point is moving along the x -axis so that at time t seconds it is at $x(t) = te^{-t^2}$. As a function of time t , find its

(a) velocity: _____ (b) acceleration: _____

- (6) (7 points) y is implicitly defined as a function of x by $\cos(\pi(x + y)) + 2xy = 2$. The point $(x, y) = (1/2, 2)$ is on the graph of this function. Find the tangent line at that point. Answer: _____

- (7) (7 points) Find the rate at which the distance between the point $(4, 0)$ and the point $(x, y) = (2 \cos(t/2), 2 \sin(t/2))$ is changing at $t = 5\pi$. _____

SHOW ALL WORK on EACH PROBLEM!

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3. RULES OF DIFFERENTIATION. (30 POINTS)

This section will be collected after 20 minutes. Until then you may **NOT** use a calculator.
Using rules of differentiation, find the derivatives of each of the following functions.

Simplify where possible.

$$(1) f(x) = \frac{x^7}{5} + \frac{3}{x^4} + 9^x, \quad f'(x) = \quad (4 \text{ points})$$

$$(2) g(t) = \frac{\cos(4t)}{1 + \sin(4t)}, \quad g'(t) = \quad (6 \text{ points})$$

$$(3) h(w) = e^{-8w} \tan(w), \quad h'(w) = \quad (6 \text{ points})$$

$$(4) p(u) = \ln(\sqrt{u}) - u \ln(u^4), \quad p'(u) = \quad (4 \text{ points})$$

$$(5) Q(x) = \frac{x^5 + 5}{x^2 + 4}, \quad Q'(x) = \quad (5 \text{ points})$$

$$(6) R(t) = \arctan(6/t), \quad R'(t) = \quad (5 \text{ points})$$

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4. MEANING AND USE OF DERIVATIVES. (50 POINTS)

Put all answers in the blanks provided. **SHOW ALL WORK!**

- (1) (10 points) Let $f(x) = 3x^2 - (1/x)$. Using the **DEFINITION** of the derivative, find $f'(x)$. Show your work in complete and careful detail. Your work is your answer. No credit for f' without the work.

$$f'(x) =$$

- (2) (8 points) Find the equation of the tangent line to the graph of $y = \sqrt[4]{x}$ at the point where $x = 10000$. Answer: _____

- (3) (3 points) **Using your previous result**, find a better approximation than 10 to $\sqrt[4]{10012}$: _____ (Note: of course you can undoubtedly find a better approximation with your calculator, but don't give me that. However, you could privately use the calculator value to check the reasonableness of your answer.)

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- (4) (7 points) The voltage across a capacitor at time t seconds is $E(t) = 0.001(1 - e^{-4t})$ volts. Give the rate of change of the voltage, with units, at $t = 3$ seconds.

The rate is: _____

- (5) (8 points) A point is moving along the x -axis so that at time t seconds it is at $x(t) = te^{-t^3}$. As a function of time t , find its

(a) velocity: _____ (b) acceleration: _____

- (6) (7 points) y is implicitly defined as a function of x by $\cos(\pi(x + y)) + 2xy = 4$. The point $(x, y) = (1/2, 4)$ is on the graph of this function. Find the tangent line at that point. Answer: _____

- (7) (7 points) Find the rate at which the distance between the point $(6, 0)$ and the point $(x, y) = (2 \cos(t/2), 2 \sin(t/2))$ is changing at $t = 5\pi$. _____

SHOW ALL WORK on EACH PROBLEM!