Math 4 Honors Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lesson 6-4: *Acceleration & Deceleration* Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Learning Goals:**

* *I can find derivatives using the Power Rule.*
* *I can use derivatives to find the velocity and acceleration of a moving object and solve problems involving particle motion.*

**Here are some additional rules for derivatives. Discuss each rule with your group members and then state in words what you think each rule means.**



*To differentiate a polynomial function with more than one term, differentiate each term using the above rules!*

**Use the above rules to differentiate each function below. Note what the degree of each derivative is. When you are done with example e, answer the two questions that follow.**



1. Verify that the surface area of a sphere is the derivative of the volume.

What is the degree of the derivative of a 9th degree function?

A function’s derivative is 5th degree, what is the degree of the original function?

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***Applications of the Derivative Rules***

**Example #1: Projectile Motion**

The position of a projectile after *t* seconds is given by the equation:

*h(t) = –*16*t*2 + 800*t –* 3

a. Find a formula for the instantaneous velocity of the projectile.

b. Find the instantaneous velocity of the projectile when *t =* 0, 5, 10, 15 and 20 seconds.

c. Find the average rate of change in velocity for each pair of *t-*values in part b.

d. Interpret the results of your work from parts b & c both conceptually and graphically.

Write your observations below and sketch graphs to support them.

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In part c of the previous example, you calculated the **acceleration** of the object. Complete the following statements about acceleration.

1. Acceleration is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a rate of change.

1. Acceleration describes how fast \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is changing.
2. When a car accelerates, its velocity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. When acceleration is negative, it is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. When a car decelerates, its velocity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
5. The **instantaneous acceleration *a(t)*,** of a projectile at time *t* is defined as the instantaneous rate of change of its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with respect to time at time *t*, and can be calculated using the formula:

*a(t) = v’(t) =*

In general, **position *h(t)*, velocity *v(t)*,** and **acceleration *a(t)***, are related as follows:

Velocity is the derivative of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Acceleration is the derivative of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

∴ acceleration is the **second derivative** of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

In symbols, this looks like:

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**Example #2: Velocity & Acceleration of an Object**

An object moves so that its position at time *t* seconds is given by the function:



a. Find the function that represents the velocity of the object.

b. Find the velocity of the object when *t =* 3 seconds. **Interpret the meaning of your calculation.**

c. Find the function that represents the acceleration of the object.

d. After one minute, is the object speeding up or slowing down? How do you know?

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**Example #3: Particle Motion**

A particle is moving along the horizontal axis in such a way that its position at time *t* is

given by the following function:



a. Determine a formula for the velocity of the particle.

b. Determine a formula for the acceleration of the particle.

c. For what values of *t* is the particle at rest? *Hint: What is its velocity when it’s at rest?*

d. When is the particle moving to the right? To the left? *Hint: NUMBER LINE ANALYSIS!*

e. What is the velocity of the particle when the acceleration is zero?

f. What is the position of the particle at *t =* 4 seconds?

g. When *t =* 3, what is the total distance traveled by the particle?

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HW: Lesson 6-4: *Acceleration & Deceleration* Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Day 1 Assignment: Complete problems 1 – 14 on this page.**

**Day 2 Assignment: Complete problems 1 – 4 on the next 2 pages.**

Notations: In addition to *f '(x)*, various notations are used to denote the derivative of *y = f(x).* The ones most commonly used are *y* ' and . should be thought of as the derivative of *y* with respect to the variable *x.*

Problems:

1.  find .

2.  find .

3.  find .

4.  find .

5.  find .

6.  find .

7.  find .

8.  find .

9.  find .

10.  find *y*’*.*

(Write your final answer in radical form.)

11. 

12.  find *y*’*.*



13.

(Write your final answer in radical form.)



14. find .

1. A particle moves along the *x*-axis in such a way that its position at time "*t*" is given by

 for.

a. Determine the velocity and acceleration of the particle at time "*t*". [find *v(t)* and *a(t)*.]

b. For what values of *t* is the particle at rest?

c. For what values of *t* does the particle change direction?

d. What is the velocity when the acceleration is first zero?

2. A particle moves along the *x*-axis in such a way that its position at time *t* is given by

, (t > 0)

a. Show that at time *t* = 0 the particle is moving to the right.

b. Find all values of *t* for which the particle is moving to the left.

c. What is the position of the particle at time *t* = 3?

d. When *t* = 3, what is the total distance the particle has traveled?

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3. A projectile is fired straight upward with a velocity of 400'/sec. Its distance above the ground *t*

seconds after being fired is given by 

a. Find the time and the velocity at which the projectile hits the ground.

b. What is its maximum altitude?

c. What is the acceleration at any time *t*?

4.

calculate *f* ‘(3).