Name: _____

Class: _____

Due Date: _____

Physics Topic 4B – Horizontal Motion in One Dimension with Calculus

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. The position of Kenny's Porsche as he zooms down the x-axis is given by the function $x(t) = 5t^3 + 4t^2 + 3t + 6$.

   a. Find formulas for his velocity and for his acceleration as functions of time.

   b. Find his initial position, velocity, and acceleration.

   c. Find his average velocity for the first three seconds.

2. The acceleration of Oliver's BMW as he zooms down the x-axis is given by the equation $a = 42t$. At $t = 2$ his velocity is $v = 144$ and his position is $x = 200$.

   a. Find formulas for his velocity and for his position as functions of time.

   b. With time on the horizontal axis sketch graphs of *x*, *v*, and *a* versus *t* for $t \geq 0$.

3. The bell rings and Mr. Harvie dashes out the door of room 25. However, he is attached to his desk by a bungee cord. His position along the x-axis is given by the function $x(t) = 60t^2 - 5t^3$.

   a. Find formulas for his velocity and for his acceleration as functions of time.

   b. At what time is his position zero?

   c. At what time is his velocity zero?

   d. At what time is his acceleration zero?

   e. During what time interval is his position positive; is his velocity positive; is his acceleration positive?

   f. Sketch a graph of his motion on the x-y axis.

g. Sketch *x*-*t*, *v*-*t*, and *a*-*t* curves.

h. Find his location at $t = 1$ and at $t = 10$.

i. Find his average velocity from $t = 1$ to $t = 10$.

j. Find his average speed from $t = 1$ to $t = 10$.

k. Find his average velocity and average speed from $t = 1$ to $t = 13$.

4. A space shuttle accelerates non-uniformly with $a(t) = 25(1 - e^{-t})$.

   a. Find its acceleration at $t = 0$ and at $t = \infty$.

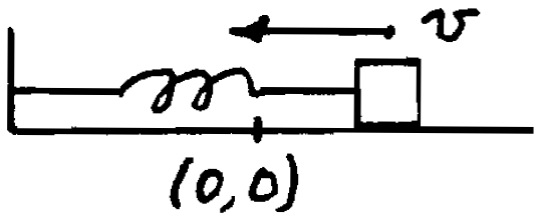
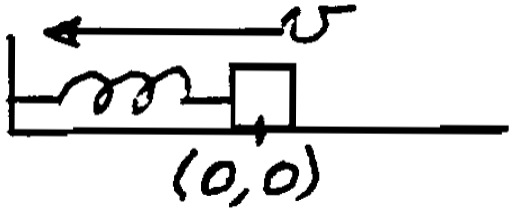
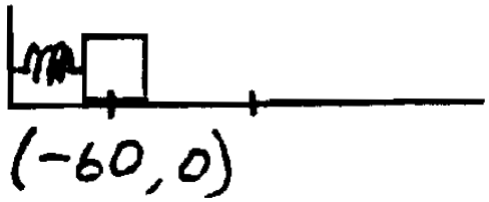
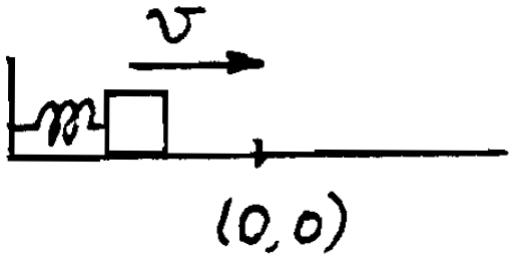
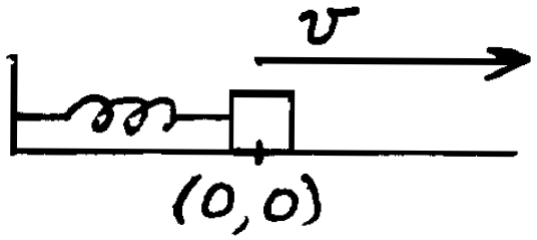
   b. The shuttle's initial velocity is zero. Find a formula for its velocity as a function of time.

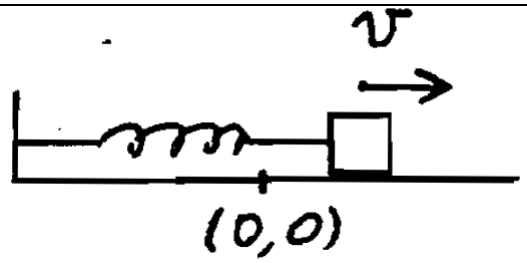
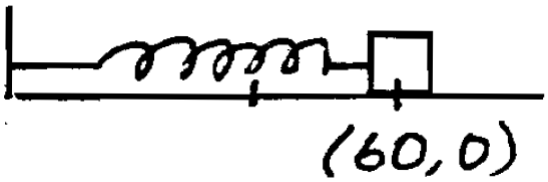
   c. The shuttle's initial position is zero. Find a formula for its position as a function of time.

   d. Sketch *a*-*t* and *v*-*t* curves.

5. A particle attached to a spring is confined to move back and forth on the horizontal axis between $x = -60$ cm and $x = 60$ cm. There is no friction. The origin is the equilibrium position. The position of the particle is given by the function $x(t) = A\cos\omega t = (60\text{ cm}) \times \cos(0.523597756t)$ where ω is given in radians per second.

   a. For each of the following determine if *x*, *v*, and *a* are positive, negative, or zero.

b. Find a formula for the particles velocity and acceleration.

c. At $t = 0, 3, 6, 9, \text{and } 12$ s calculate the particles position, velocity, and acceleration. Please set your calculator to radians.

	0 s	3 s	6 s	9 s	12 s
$\vec{x}$					
$\vec{v}$					
$\vec{a}$					

d. Calculate the particles average velocity $\bar{\vec{v}}$ for the following time intervals:

	$\bar{\vec{v}}$
$t = 0$ to $t = 12$ s	
$t = 0$ to $t = 3$ s	
$t = 0$ to $t = 6$ s	
$t = 6$ to $t = 9$ s	
$t = 6$ to $t = 12$ s	
$t = 3$ to $t = 12$ s	

e. Calculate the particles average speed $\bar{v}$ for the same time intervals.

	$\bar{v}$
$t = 0$ to $t = 12$ s	
$t = 0$ to $t = 3$ s	
$t = 0$ to $t = 6$ s	
$t = 6$ to $t = 9$ s	
$t = 6$ to $t = 12$ s	
$t = 3$ to $t = 12$ s	

f. When $x = 30$ calculate *t*, *v*, and *a*.

Take a break and play this video game:
https://universeandmore.com/motion-mapper/