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DLI Physics

Mechanics Problem Set 1

Name_____

Applied Derivatives in Mechanics
Date 17th.500

- 1. A honeycrisp apple moves in a straight line with its position, x, given by the following equation: $x(t) = t^4 4t^3 + 2t^2 + 3t + 6$
 - a. Find its position after 1 second.
 - b. Find its velocity after 2 seconds.
 - c. Find its acceleration after 3 seconds.
 - d. What is the rate of change of the acceleration at 1 second.
 - e. Use Python to graph the position, velocity and acceleration as functions of time from t=0 to t=4 seconds.
 - f. Use Python to graph the rate of change of acceleration vs. time.

(b)
$$\frac{dx}{dt} = 443 - 12t^2 + 844t + 3$$

$$ac35) = 108 - 72 + 4$$

$$= 40 \, \text{m/s}^2$$

$$\frac{da}{dt} = 24t - 24$$

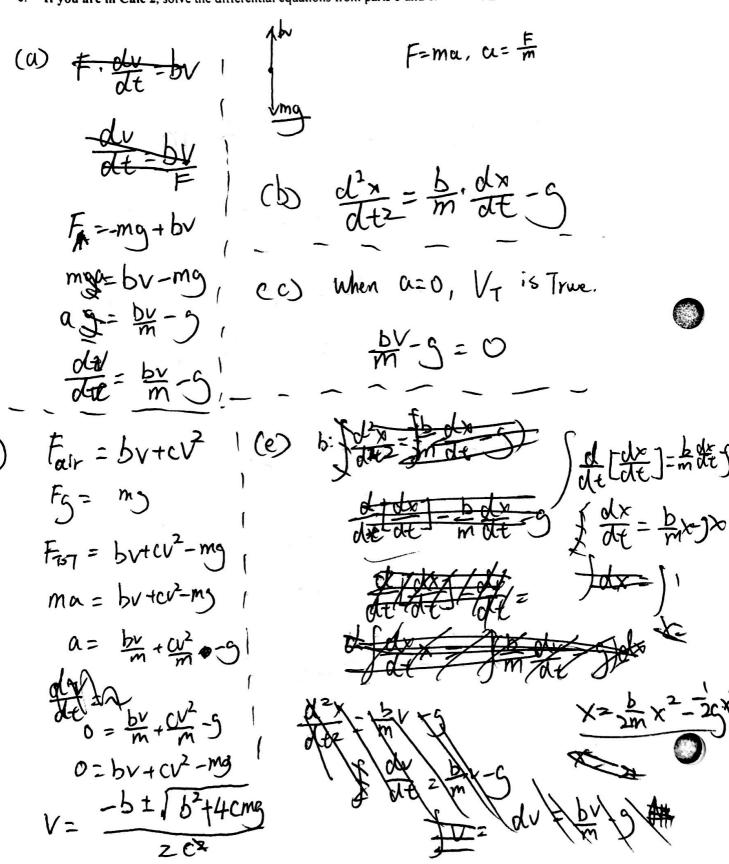
$$acD = 0$$



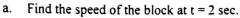
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2. A sky-diver of mass, m, opens her parachute and finds that the air resistance. Fa, is given by the formula Fa= bv, where b is a constant and v is the velocity.

- a. Set up, but do not solve a differential equation for her velocity as a function of time.
- b. Set up, but do not solve a differential equation for distance as a function of time.
- c. Find the terminal velocity in terms of m, b, and g.
- d. If in a different situation the formula for air resistance were Fa= bv +cv², where c is another constant find the terminal velocity in terms of the above plus c.
- e. If you are in Calc 2, solve the differential equations from parts b and c.



3. Oompa-Loompas are pulling a 2 kg crate of golden eggs along a rough, but level, surface. In one case it is determined that the position of the block as a function of time is given by: $x(t) = .3t^3 - .1t^2 + .2t$.



- b. Find an expression for acceleration as a function of time.
- c. Find an expression for force as a function of time. $(\vec{a} = \frac{\vec{E}}{m})$
- d. Find the initial kinetic energy of the block ($KE = \frac{1}{2}mv^2$)
- e. Find the change in kinetic energy of the block from t = 0 to t = 2 sec.
- f. Another lab group determines that the Oompa-Loompa force as a function of distance is given by:

 $F(x) = x^2 + 2x + 2$ and the block is pulled at an angle of 15° to the horizontal.

Find the change in kinetic energy from x = 0 to x = 2 meters.

g. For the above group find a differential equation for power (Power = the time rate of change of kinetic energy).

(a)
$$\frac{dx}{dt} = 40.9t^2 - 0.2t + 0.2$$

 $v(2) = 3.6 - 0.80.4 + 0.2$
 $= 43.4 \text{ m/s}$





P= mva