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 $x(t) = .3t^3 - .1t^2 + .2t$

a. Find the speed of the block at t = 2 sec.
b. Find an expression for acceleration as a function of time.
c. Find an expression for force as a function of time. ($\vec{a} = \frac{\vec{F}}{m}$)
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. $(0.3t^3 - 0.1t^2 + 0.2t)'$

$= 0.9t^2 - 0.2t + 0.2$

$v(2) = (0.9)(4) - (0.2)(2) + 0.2$

$= 3.6 - 0.4 = 3.2 + 0.2 = \boxed{3.4}$

b. $\boxed{a(t) = 1.8t - 0.2}$

c. $a = \frac{F}{m}$, $m = 2kg$

$F = ma$

$= (1.8t - 0.2)(2kg)$

$\boxed{3.6t - 0.4}$

d. $KE = \frac{1}{2}m(v_0)^2$

$= (\frac{1}{2})(2kg)(0.2)^2$

$= \boxed{0.04\,J}$

e.

$KE(2) = \frac{1}{2}mv^2$

$= (\frac{1}{2})(2kg)(3.4)^2$

$= 11.56\,J$

$11.56\,J - 0.04 = \boxed{11.52\,J}$

f. $\int_0^2 x^2 + 2x + 2$

$= \frac{x^3}{3} + \frac{(2)(x)^2}{2} + 2x \Big|_0^2$

$= \frac{x^3}{3} + x^2 + 2x \Big|_0^2$

$= \frac{8}{3} + 4 + 4 = \frac{8}{3} + \frac{24}{3} = \boxed{\frac{32}{3}}$

g. $P = \frac{d}{dt}(\frac{1}{2}mv^2)$

$= mv\frac{dv}{dt} = \boxed{mva}$