Level 4: Algebraic Box   Name ______________________

A little kid is playing on a swing!
Assume that friction and air resistance are negligible, and the kid is swinging without adding energy to the system (pumping).

At the bottom of the swing, he reaches a velocity v_{max} and a height h_{min}
At the top of the swing, his velocity is zero and his height is h_{max}.
In the middle of the swing, his velocity is $v_{halfway}$ and his height is the average of h_{max} and h_{min} .

1. Fill out the table below in terms of h_{max} and h_{min} , the mass of the kid *m*., and the free fall acceleration *g*.

Note that you may NOT include v_{max} and $v_{halfway}$ as variables in the box. Also, do not write a number for free-fall acceleration, instead indicate it by the variable *g*.

You may consider that GPE = 0 at the group (height = 0), which the playground swinger does not reach.

Point	**Height**	**Velocity**	**KE**	**GPE**	**Total Energy**
Top					
Halfway					
Bottom					

Show the work necessary to fill in the table in this space:

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2. Based upon the table
Write equations for $v_{halfway}$ and v_{max}.
Prove your equations are dimensionally correct.

3. What is the proportionality relationship between v_{max} and Δh, in which $\Delta h = h_{max} - h_{min}$?

4. If you solved correctly, the mass of the playground swinger should not be included in any of the formulas for velocity. Explain conceptually why this makes sense, referring if necessary to findings from other areas of physics.

Algebraic Horizontal Spring

A mass of mass m is attached to a horizontal spring that has spring constant k and equilibrium length x_0. The spring is on a frictionless surface, and the spring can be approximated as a massless spring.
Somebody pulls the spring backwards until it has a length x_1.
At this point, the mass-spring system has elastic potential energy.

The person then lets go. Fill out the table below in terms of k, x_0, and x_1.
Note that the variable m is not necessary to fill out this table:

Point	Description	Length of the Spring	Kinetic Energy	Elastic Potential Energy	Total Energy of the System.
A	The spring is initially pulled back				
B	The spring is back at its equilibrium length				
C	The spring is fully compressed				
D	The spring is back at its equilibrium length a second time.				
E	The spring returns to the initial point.				

At which points is the mass in motion?

At which points does the mass have speed zero?

At each point the mass is moving,
determine the speed of the mass in terms of m, k, x_0, and x_1