Energy Test Redux **Name:**________________________

Complete both of the FR Questions. Your lowest FR score will be replaced by the average of these two scores.

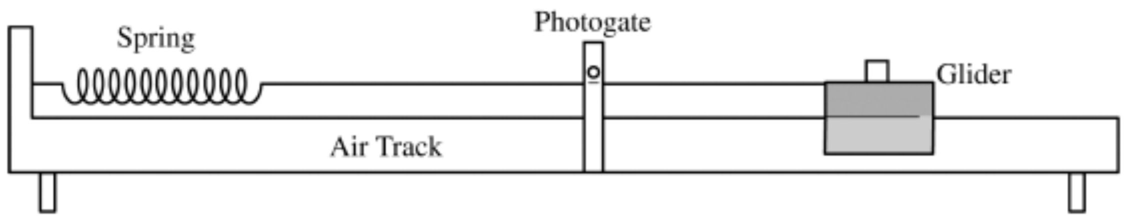
1. A special nonlinear spring is constructed in which the restoring force is in the opposite direction to the displacement, but is proportional to the *cube of the displacement;* i.e., $F = -kx^3$. This spring is placed on a horizontal frictionless surface. One end of the spring is fixed, and the other end is fastened to a mass M. The mass is moved so that the spring is stretched a distance A and then released.

Determine each of the following in terms of k, A, and M.

a. The potential energy in the spring at the instant the mass is released

b. The maximum speed of the mass

c. The displacement of the mass at the point where the potential energy of the spring and the kinetic energy of the mass are equal.

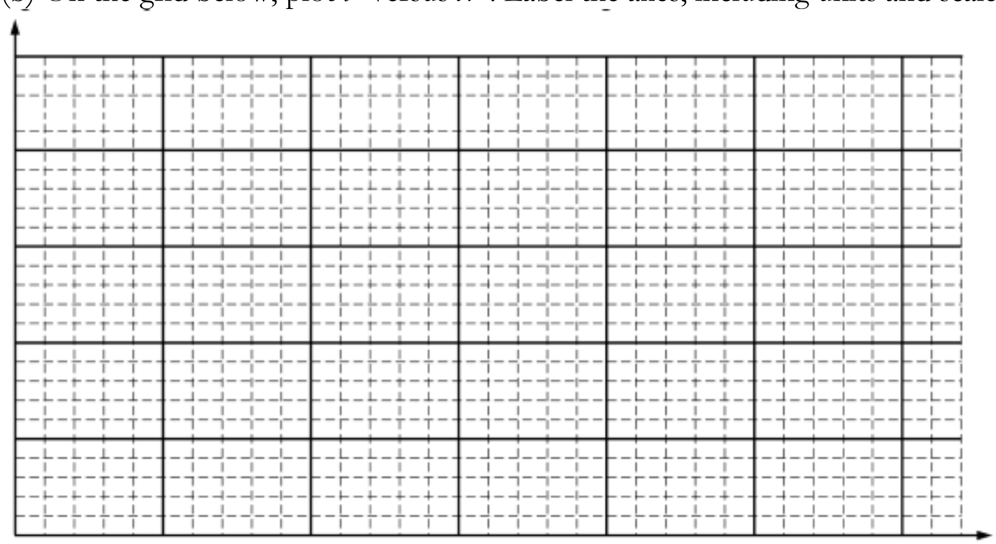


2. The apparatus above is used to study conservation of mechanical energy. A spring of force constant 40 N/m is held horizontal over a horizontal air track, with one end attached to the air track. (You may assume little to no friction on an air track.) A light string is attached to the other end of the spring and connects it to a glider of mass *m*. The glider is pulled to stretch the spring an amount *x* from equilibrium and then released. Before reaching the photogate, the glider attains its maximum speed and the string becomes slack. The photogate measures the time *t* that it takes the small block on top of the glider to pass through. Information about the distance *x* and the speed *v* of the glider as it passes through the photogate are given below.

Trial #	Extension of the Spring x (m)	Speed Glider v (m/s)	Extension Squared x^2 (m^2)	Speed Squared v^2 (m^2/s^2)
1	0.30×10^{-1}	0.47	0.09×10^{-2}	0.22
2	0.60×10^{-1}	0.87	0.36×10^{-2}	0.76
3	0.90×10^{-1}	1.3	0.81×10^{-2}	1.7
4	1.2×10^{-1}	1.6	1.4×10^{-2}	2.6
5	1.5×10^{-1}	2.2	2.3×10^{-2}	4.8

(a) Assuming no energy is lost, write the equation for conservation of mechanical energy that would apply to this situation.

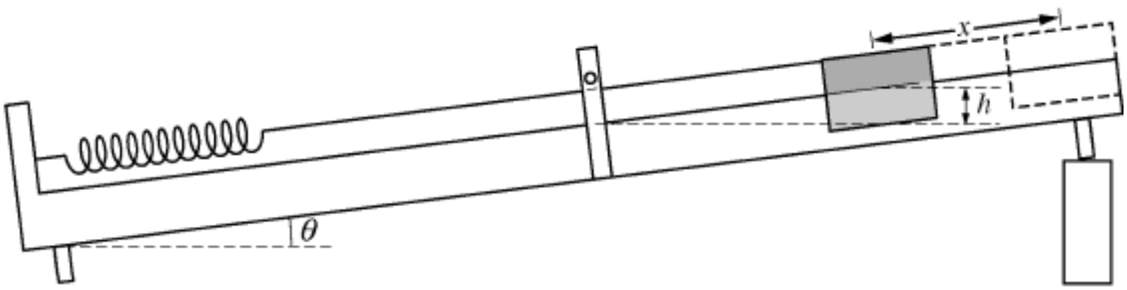
(b) On the grid below, plot v^2 versus x^2 . Label the axes, including units and scale.



(c) (i) Draw a best-fit straight line through the data.

(ii) Use the best-fit line to obtain the mass m of the glider.

(d) The track is now tilted at an angle theta as shown below. When the spring is unstretched, the center of the glider is a height h above the photogate. The experiment is repeated with a variety of values of x.



(i) Assuming no energy is lost, write the new equation for conservation of mechanical energy that would apply to this situation.

(ii) Will the graph of v^2 versus x^2 for this new experiment be a straight line?

________Yes ________No

Justify your answer.