Name ______________________________
AP Physics
Period __________

Date ____________________________
AP Review # 2
Mrs. Nadworny

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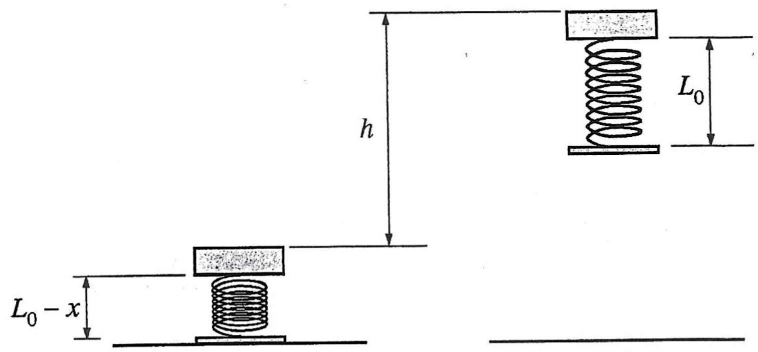

Compressed Spring on Table

Released Spring at Maximum Height

1. (15 points)

In an experiment, students are to calculate the spring constant k of a vertical spring in a small jumping toy that initially rests on a table. When the spring in the toy is compressed a distance x from its uncompressed length L_0 and the toy is released, the top of the toy rises to a maximum height h above the point of maximum compression. The students repeat the experiment several times, measuring h with objects of various masses taped to the top of the toy so that the combined mass of the toy and added objects is m. The bottom of the toy and the spring each have negligible mass compared to the top of the toy and the objects taped to it.

3 (a) Derive an expression for the height h in terms of m, x, k, and fundamental constants.

(1) $PE_s = PE_g$

(1) $\frac{1}{2}kx^2 = mgh$

$h = \frac{kx^2}{2mg}$ (1)

With the spring compressed a distance $x = 0.020$ m in each trial, the students obtained the following data for different values of m.

(1) units

$y = m\ x$

$h = \frac{kx^2}{2g}\left(\frac{1}{m}\right)$

$1/m$ (1/kg)	m (kg)	h (m)	
50	0.020	0.49	
33	0.030	0.34	
25	0.040	0.28	
20	0.050	0.19	
17	0.060	0.18	

(1) data

(b)

2 i. What quantities should be graphed so that the slope of a best-fit straight line through the data points can be used to calculate the spring constant k ?

h vs $\frac{1}{m}$ (2) or m + $1/h$ or h vs $\frac{x^2}{2mg}$ (slope = k)

2 ii. Fill in one or both of the blank columns in the table with calculated values of your quantities, including units.

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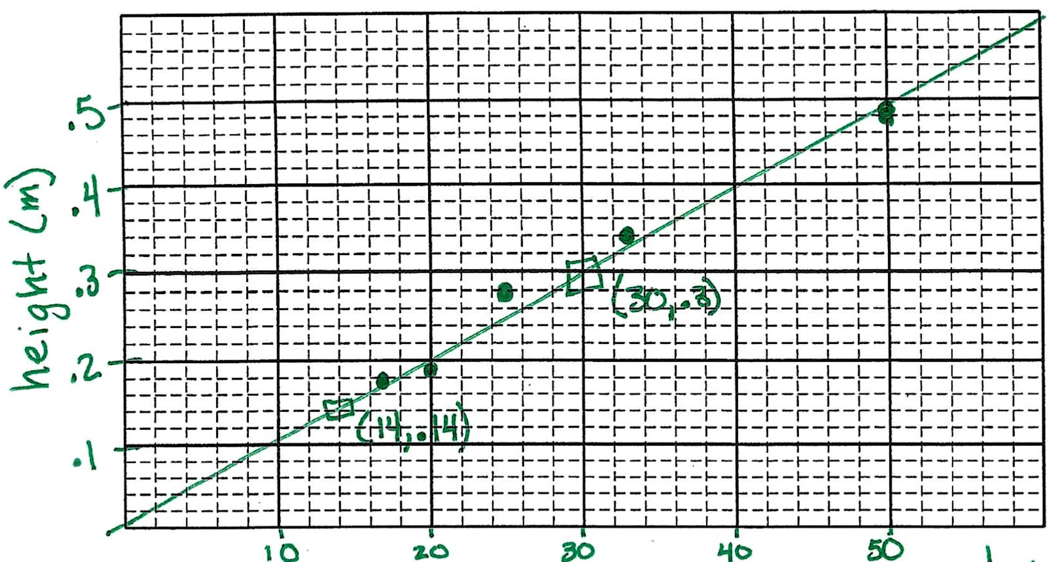
4 (c) On the axes below, plot your data and draw a best-fit straight line. Label the axes and indicate the scale.

(1) data
(1) best fit
(1) label
(1) scale



$\frac{1}{m}\left(\frac{1}{kg}\right)$

2 (d) Using your best-fit line, calculate the numerical value of the spring constant.

① $m = \frac{\Delta y}{\Delta x} = \frac{.3m - .14m}{30\,^1/_{kg} - 14\,^1/_{kg}} = .01\ mkg$

(1) slope

② $\text{slope} = \frac{kx^2}{2g}$ $\quad k = \frac{2g(\text{slope})}{x^2} = \frac{2(9.81\ m/s^2)(.01\ mkg)}{(.020m)^2} = 490\ N/m$

(1) k

2 (e) Describe a procedure for measuring the height h in the experiment, given that the toy is only momentarily at that maximum height.

• Use a meterstick + watch how high it reaches

(or other valid method)

just "meterstick" = 1pt

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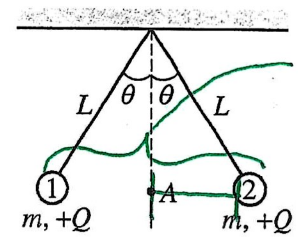


$r_{\text{sphere to sphere}} = 2L\sin\theta$

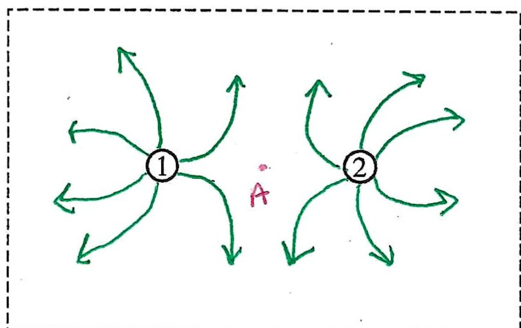
$r_A = L\sin\theta$

2. (10 points)

Two small objects, labeled 1 and 2 in the diagram above, are suspended in equilibrium from strings of length L. Each object has mass m and charge $+Q$. Assume that the strings have negligible mass and are insulating and electrically neutral. Express all algebraic answers in terms of m, L, Q, θ, and fundamental constants.

3 (a) On the following diagram, sketch lines to illustrate a 2-dimensional view of the net electric field due to the two objects in the region enclosed by the dashed lines.

(1) direction
(1) shape + symmetry
(1) blank at A



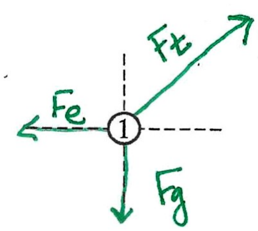
2 (b) Derive an expression for the electric potential at point A, shown in the diagram at the top of the page, which is midway between the charged objects.

$V_1 = \frac{kq_1}{r}$ $\quad V_{net} = V_1 + V_2 = \frac{kq_1}{r_1} + \frac{kq_2}{r_2} = \frac{2kq}{r}$

(1) sum

$V_2 = \frac{kq_2}{r}$ $\quad = \frac{2kQ}{L\sin\theta}$ (1) correct, NOT in R!

2 (c) On the following diagram of object 1, draw and label vectors to represent the forces on the object.



(1) all vectors w/arrows
(1) labels

3 (d) Using the conditions of equilibrium, write—but do not solve—two equations that could, together, be solved for θ and the tension T in the left-hand string.

$\Sigma F_y = 0N$ $\quad \Sigma F_x = 0N$

$F_{ty} - F_g = 0N$ (1) $\quad F_{tx} - F_e = 0N$ (1)

$F_t\cos\theta = mg$ $\quad F_t\sin\theta = \frac{kq^2}{r^2}$ $\leftarrow r = 2L\sin\theta$

$T\cos\theta = mg$ $\quad F_t\sin\theta = \frac{kq^2}{(2L\sin\theta)^2}$

$T\sin\theta = \frac{kQ^2}{4L^2(\sin\theta)^2}$

(1) both eqns in terms of given variable