. A student has designed an experiment to find out the spring constant k of a spring attached to a ball launcher. He placed the ball launcher in a horizontal table and connected it to a frictionless curved ramp as shown in figure 1.
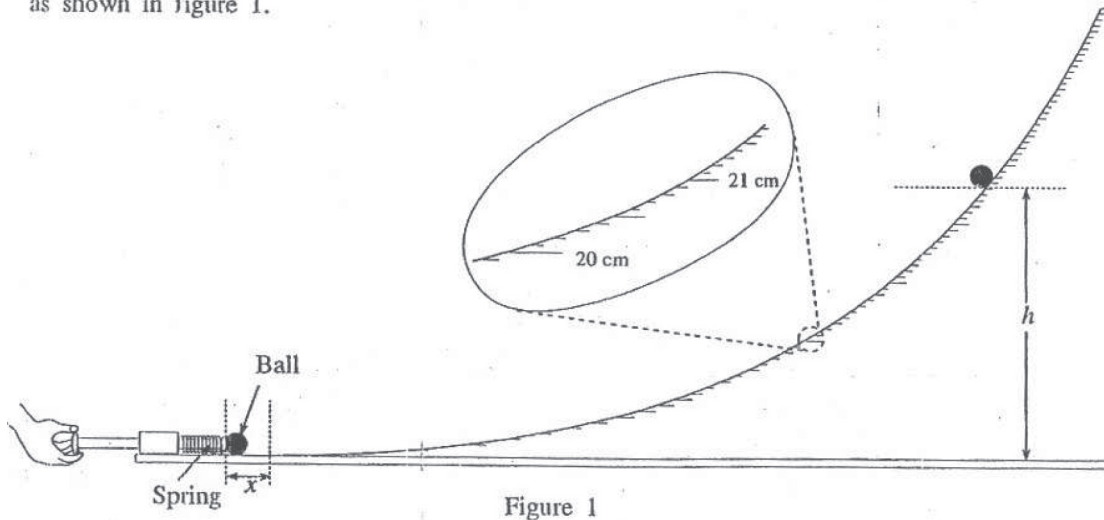

Figure 1

The student compressed the spring by a distance x from its natural length and placed a ball of mass M as shown in the figure. He subsequently ejected the ball by releasing the spring so that the ball climbs along the ramp to a maximum vertical height h without rolling.

To measure the vertical height h, student has used a properly calibrated scale marked along the ramp as shown in the figure.

(a) Write down the least count of the scale marked on the ramp.

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(b) When the spring is compressed by a distance x, write down an expression for the stored energy (E) in the spring in terms of k and x.

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(c) Write down an expression for the gravitational potential energy (U) that the ball will gain when it reached the height h after the spring is released.

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(d) Using your expressions in (b) and (c) obtain an expression for the height h, in terms of M, x, k and acceleration due to gravity g. (Assume that the entire stored energy in the spring is transferred to the ball.)

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(e) Name the principle that you have used to obtain the expression in (d).

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(f) To find the spring constant k, the student has plotted a graph of h vs x^2 as shown in figure 2.

$h \times 10^{-2}$ (m)

Figure 2
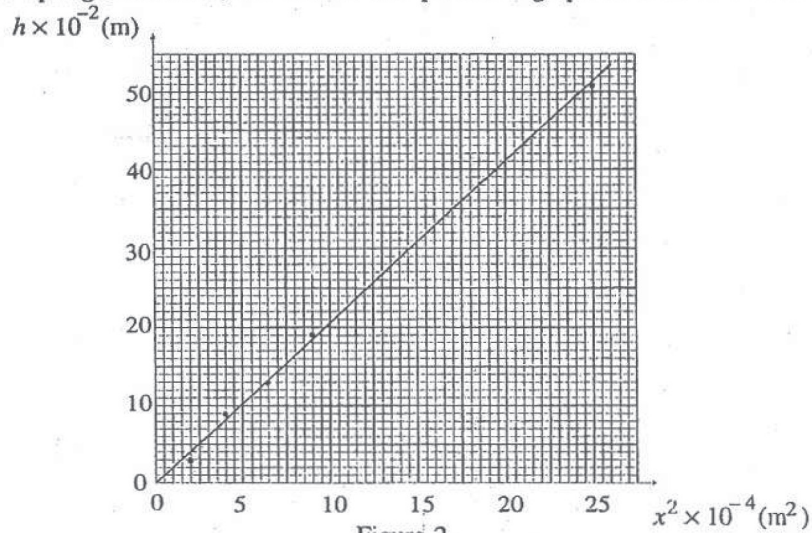
(i) The teacher says that the graph is unsatisfactory. Why do you think it is unsatisfactory?

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(ii) What measure would you take in this experiment to improve the graph?

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(g) If the gradient obtained from the improved graph is 200 m^{-1} and the value of M is 0.125 kg find the spring constant k.

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(h) In this experiment the student measures the compression x and the corresponding height h. Which one of these two measurements has to be taken more accurately than the other? What is the reason for this?

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