3. You are asked to verify the lens formula by plotting a suitable graph, and to determine the focal length of a convex lens. A partly assembled set-up that can be used for this purpose is shown in the following diagram. U is the object distance. You are provided with an object pin P_1, lens L, locating pins (P_2 and P_3; one short and other tall) and a white screen S.
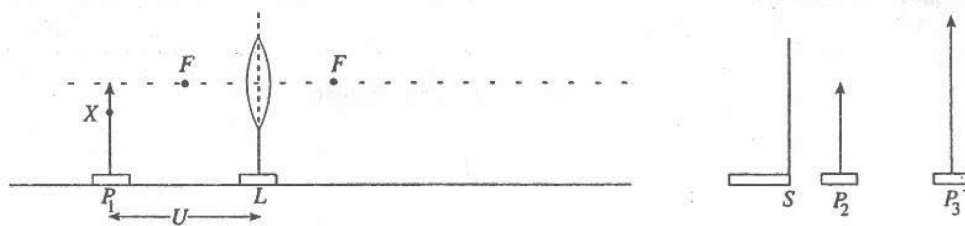
(a) Considering two light rays coming from point X marked on P_1, draw a suitable ray diagram to locate the image of the object pin P_1.

(b) (i) Draw the screen S at an appropriate place in the above diagram.

(ii) What is the purpose of keeping S at the place where you have drawn it?

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(c) (i) To determine the image distance (V) of the object pin P_1, the locating pin P_2 has to be used and you have to place your eye at a suitable position. Label this position as E in the above diagram.

(ii) How do you make sure that the image of P_1 coincides with P_2 ?

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(d) Suppose you want to take a few readings with virtual images too. Draw the object pin and the locating pin at appropriate places for taking such a reading, and label them as P_1, P_2 or P_3 in the following diagram (positioning them at exact locations is **not** necessary).
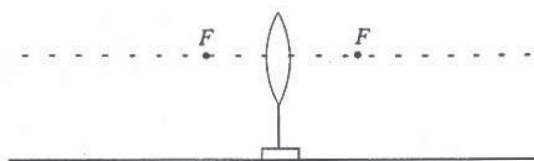
(e) (i) Draw a graph that you would expect to obtain on the following grid. Your graph must contain data points for real images as well as virtual images. Label the axes.
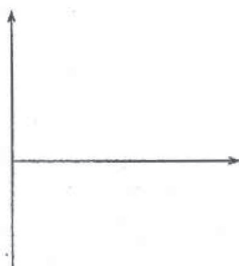
(ii) What is the expected gradient of the graph?

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(iii) How do you determine the focal length of the lens from the graph?

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(f) A student says that in the case of real images when one pair of U and V values are obtained, two data points could be plotted, on the graph. Would you agree with this? Give reasons for your answer.

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