3 **(a)** Define *simple harmonic motion*.

……

……

…… [1]

(b) A needle-carrier is used in a sewing machine to constrain the movement of the needle to a vertical line only. Low friction guides are used to achieve this. The simple harmonic motion of the needle-carrier is produced by a rotating disc carrying a peg which moves in a circle and engages with a slot attached to the needle carrier, as shown in Fig. 3.1 below.

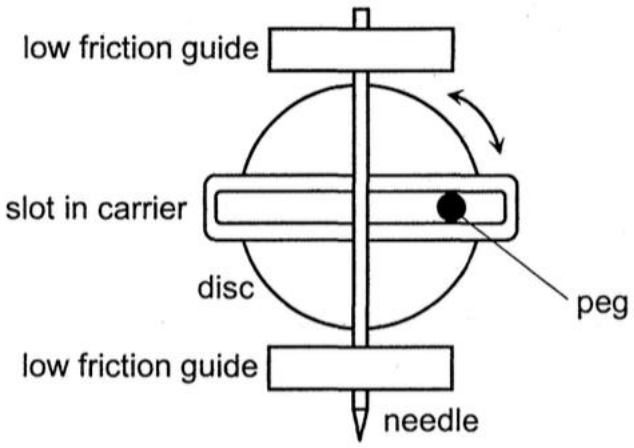

Fig. 3.1

(i) Show that the angular speed of the disc's circular motion that results in the peg having an oscillation frequency of 12 Hz is 75 rad s^{-1}.

[1]

(ii) The carrier and needle have a combined mass of 25 g and the needle's tip moves a distance of 32 mm from its highest point to its lowest.

Calculate the maximum speed of the needle.

maximum speed = …….. m s^{-1} [2]

(iii) Assuming that the needle requires negligible force to penetrate the fabric being sewn, calculate the maximum contact force acting on the peg by the slot.

maximum contact force = …….. N [2]

(iv) Draw on Fig. 3.2 below the position of the peg at which the:

1. needle is at its maximum speed (label as **1**), and
2. the peg experiences the maximum contact force by the slot (label as **2**)

Front view of disc

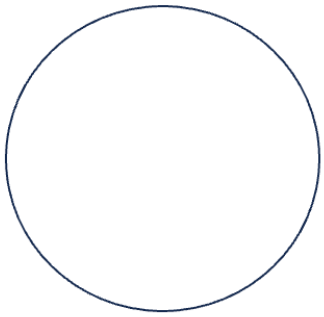

Fig. 3.2

[2]

[Total: 8]