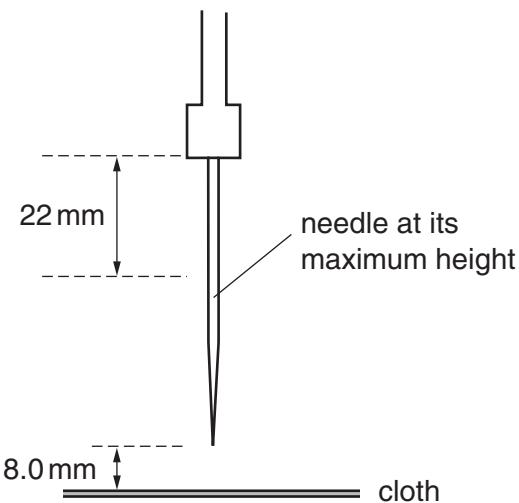


- 3 The needle of a sewing machine is made to oscillate vertically through a total distance of 22 mm, as shown in Fig. 3.1.



**Fig. 3.1**

The oscillations are simple harmonic with a frequency of 4.5 Hz.

The cloth that is being sewn is positioned 8.0 mm below the point of the needle when the needle is at its maximum height.

- (a) State what is meant by *simple harmonic motion*.

.....  
.....  
.....

[2]

- (b) The displacement  $y$  of the point of the needle may be represented by the equation

$$y = a \cos \omega t.$$

- (i) Suggest the position of the point of the needle at time  $t = 0$ .

.....

[1]

- (ii) Determine the values of

1.  $a$ ,

$$a = \dots \text{mm} [1]$$

2.  $\omega$ .

$$\omega = \dots \text{rad s}^{-1} [2]$$

(c) Calculate, for the point of the needle,

(i) its maximum speed,

For  
Examiner's  
Use

$$\text{speed} = \dots \text{ms}^{-1} [2]$$

(ii) its speed as it moves downwards through the cloth.

$$\text{speed} = \dots \text{ms}^{-1} [3]$$