3   (a)   A block of mass 0.40 kg slides in a straight line with a constant speed of 0.30 m s$^{-1}$ along a horizontal surface, as shown in Fig. 3.1.
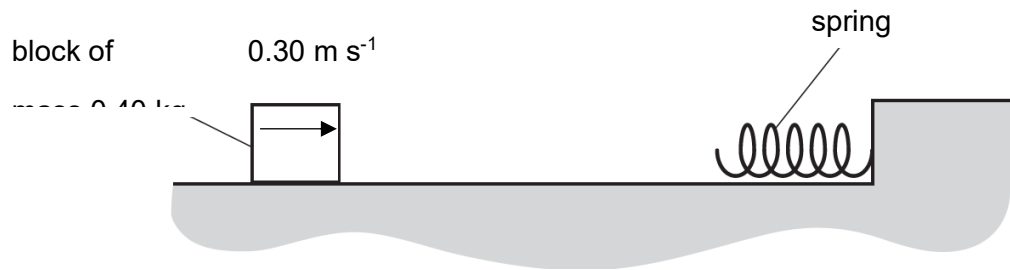
block of          0.30 m s$^{-1}$                                    spring

mass 0.40 kg



**Fig. 3.1**

The block hits a spring and decelerates. The speed of the block becomes zero when the spring is compressed by 8.0 cm.

(i)   Calculate the initial kinetic energy of the block.

kinetic energy = ……………………J [1]

(ii)   The variation of the compression $x$ of the spring with the force $F$ applied to the spring is shown in Fig. 3.2.
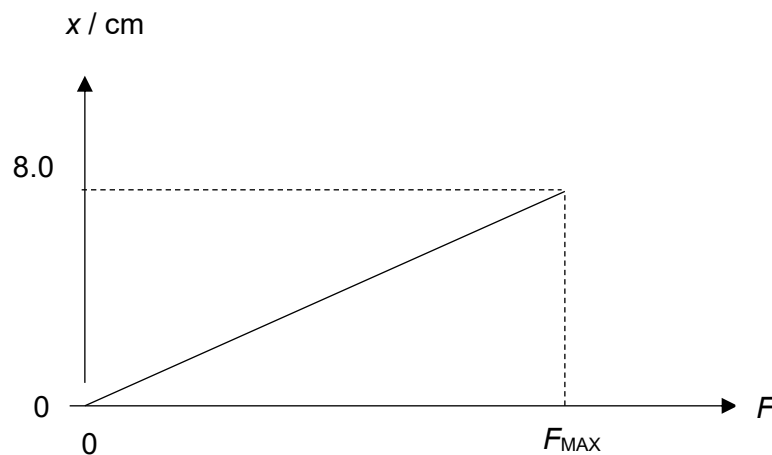
**Fig. 3.2**

Use your answer in **(a)(i)** to determine the maximum force $F_{MAX}$ exerted on the spring by the block. Explain your working.

$F_{MAX}$ = ………………….N [3]

**(iii)** Calculate the maximum deceleration of the block.

deceleration = ……………….m s$^{-2}$ [1]

**(iv)** State and explain whether the block is in equilibrium

**1.** before it hits the spring,

…………………………………………………………………………………………………
.......

……………………………………………………………………………………………………………
...[1]

**2.** when its speed becomes zero.

…………………………………………………………………………………………............
......

……………………………………………………………………………………………………………
...[1]

**(b)** The mass $m$ of the block in **(a)** is now varied. The initial speed of the block remains constant and the spring continues to obey Hooke's law.

On Fig. 3.3, sketch the variation of the maximum compression $x_0$ of the spring with the mass $m$.

$x_0$

0

0                                                    *m*

[2]                          **Fig. 3.3**