16 The suspension system in a car includes a spring attached to each wheel as shown.

(Source: © Macrovector/Shutterstock)

The car, of mass 1100 kg, is stationary. Each spring is compressed by 152 mm due to a quarter of the weight of the car. Each spring is well within both the limit of proportionality and the elastic limit.

(a) State what is meant by within the elastic limit.

(1)

(b) (i) Show that the stiffness of each spring is about 18 000 $N\,m^{-1}$.

(3)

(ii) A force is applied to the car which results in a further small compression of each spring. The force is then removed, and the body of the car oscillates with simple harmonic motion.

Determine the frequency of the oscillations.

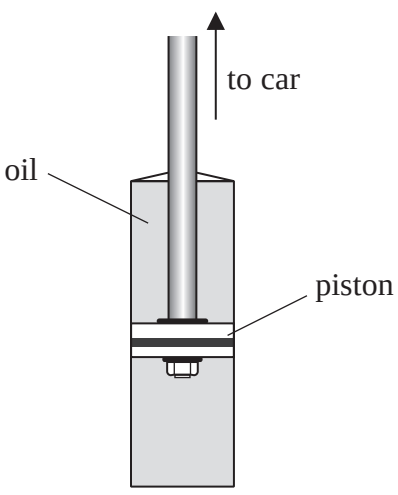
(3)

Frequency = ...

(c) State the conditions for simple harmonic motion.

(2)

(d) The oscillations are heavily damped by a piston in the suspension system. The piston moves within a cylinder filled with oil, as shown. The oil has a high viscosity.



Explain why using oil of high viscosity will produce heavy damping.

(3)

(Total for Question 16 = 12 marks)