Answer **one** question from this section in the spaces provided.

8 The force–extension graph for a light spring is shown in Fig. 8.1.

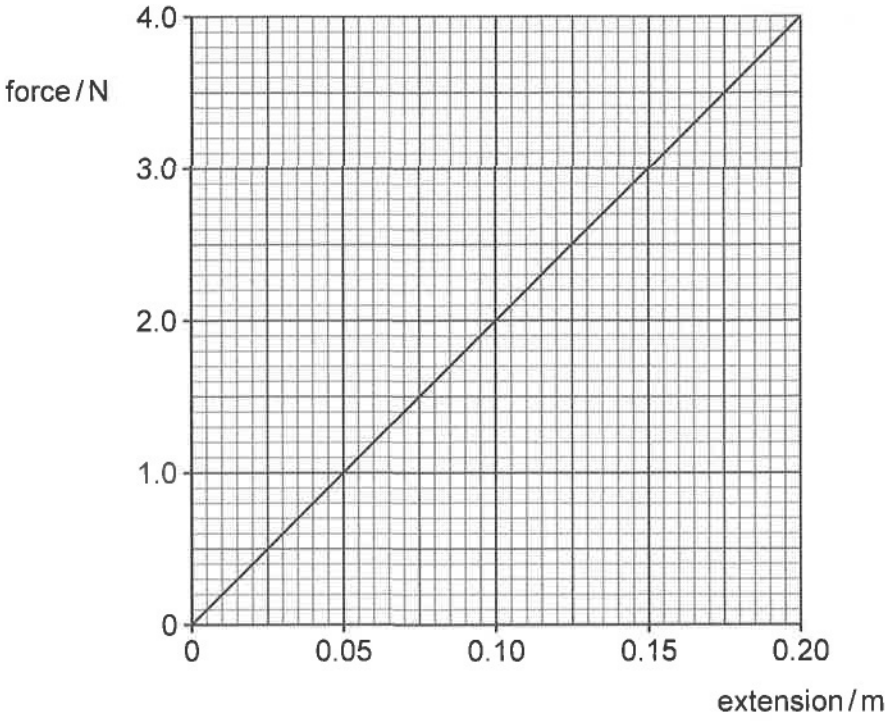

Fig. 8.1

The light spring hangs vertically from a fixed point.

An object of weight 3.0 N is attached to the free end of the unstretched spring. The object stretches the spring until stationary equilibrium is reached, as shown in Fig. 8.2.

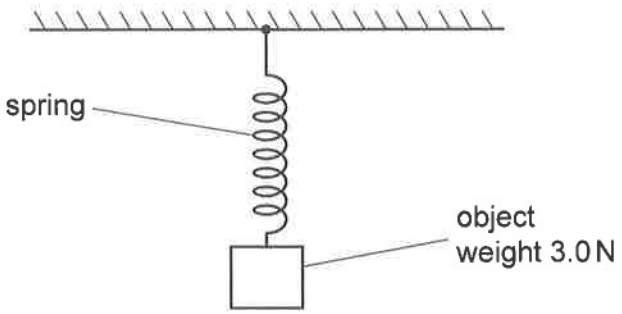

Fig. 8.2

(a) Calculate:

(i) the force constant k of the spring

k = ... N m^{-1} [1]

(ii) the energy stored in the spring due to the extension caused by the object

energy = ... J [2]

(iii) the total gravitational potential energy (GPE) transferred by the object.

GPE transferred = ... J [1]

(b) Explain, in terms of energy, why the answers to **(a)(ii)** and **(a)(iii)** are different.

.....

.....

..... [2]

(c) The object is now held stationary at a distance of 3.2 cm below the equilibrium position, as shown in Fig. 8.3.

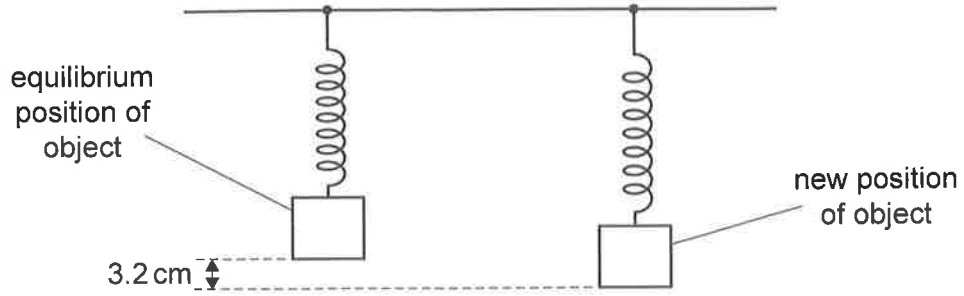

Fig. 8.3

Show that, when released, the object's acceleration a is related to its displacement x from the equilibrium position by the equation:

$$a = -\frac{k}{m}x$$

where m is the mass of the object.

Explain your working.

[3]

(d) The object undergoes simple harmonic oscillations described by the equation in **(c)**. The amplitude of the oscillations is 3.2 cm. The object first passes through the equilibrium position at time $t = 0$.

When $t = 0.50$ s, calculate the magnitude of:

(i) the displacement of the object from its equilibrium position

displacement = ... cm [2]

(ii) the velocity of the object.

velocity = ... cm s^{-1} [2]

(e) In practice, the oscillations of the object are lightly damped.

On Fig. 8.4, sketch a graph to show a possible variation of the displacement x of the object from its equilibrium position with time t. The graph should extend from $t = 0$ to $t = 3T$, where T is the period of the oscillations.

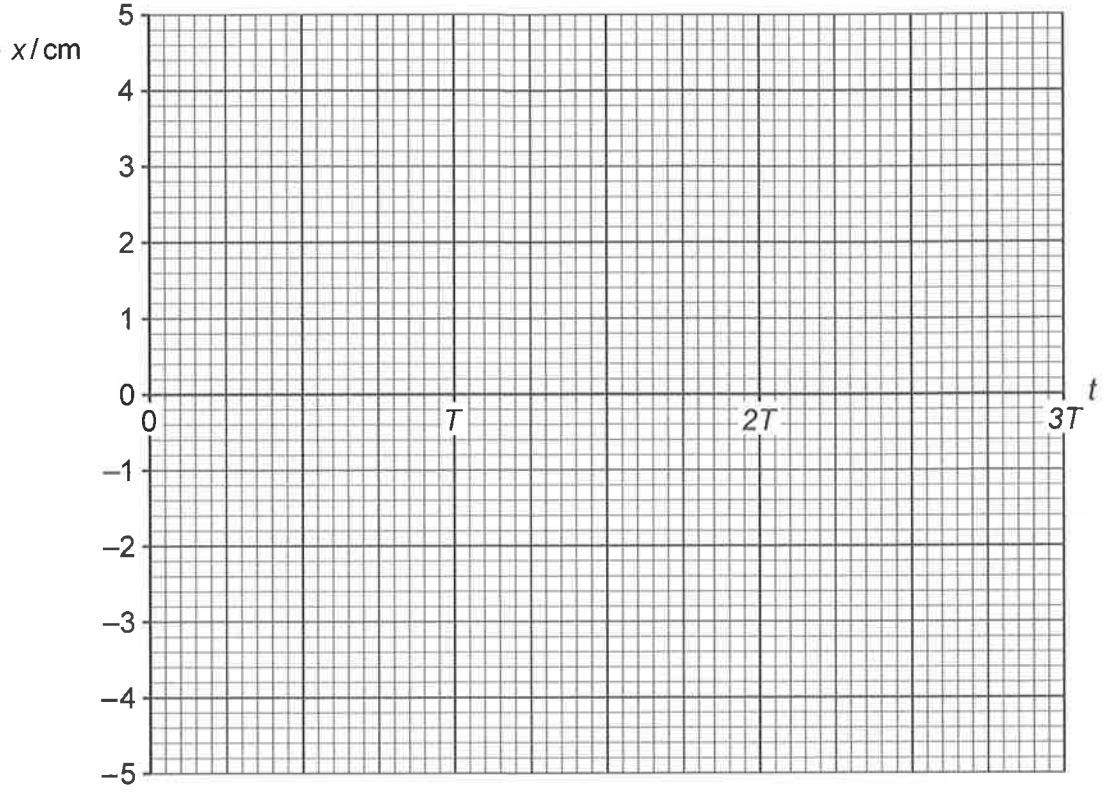

Fig. 8.4

[3]

(f) An identical spring is now attached to the original spring.

The original object is attached to the spring combination and the system is in equilibrium, as shown in Fig. 8.5.

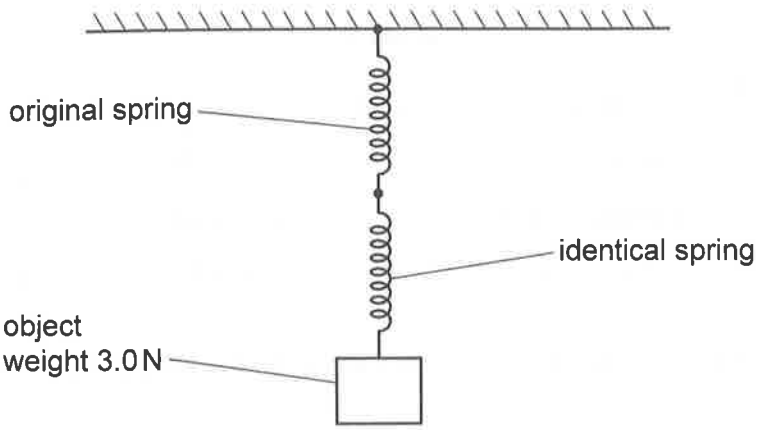

Fig. 8.5

(i) State and explain how the extension of the spring combination compares with the extension of the single original spring.

.....

.....

..... [2]

(ii) The object is pulled down a small distance and released so that it oscillates.

State and explain how the period of these oscillations compares with the period of oscillations in **(c)**.

.....

.....

..... [2]

[Total: 20]