7 (a) State the conditions for a body to remain in static equilibrium.

....

....

.... [2]

(b) A uniform rod of length L and weight 120 N is supported by two springs as shown in Fig. 7.1. A 400 N weight is suspended one quarter way from the left end.

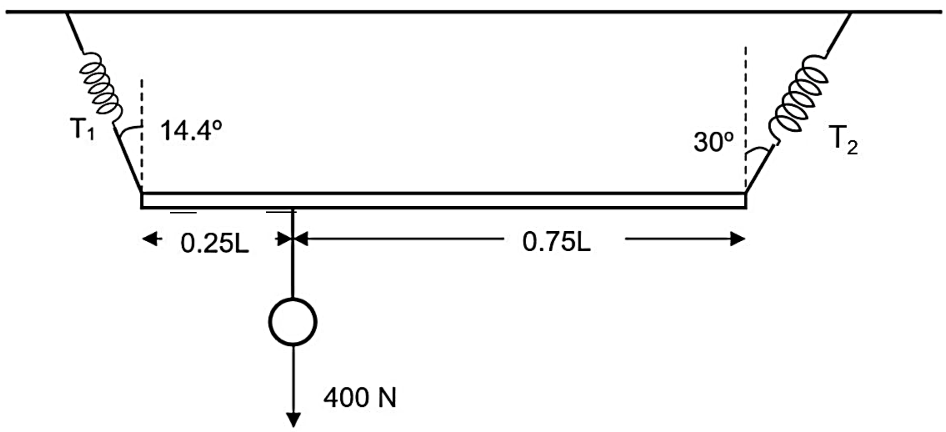

Fig. 7.1

Determine the tensions T_1 and T_2 that are exerted on the springs.

T_1 = ...N

T_2 = ...N [4]

(c) Distinguish between frequency and angular frequency for a body undergoing simple harmonic motion.

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

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

……………………………………………………………………………………………………........................ [2]

(d) A block of mass m which is 38 g is attached to two identical stretched springs, as shown in Fig. 7.2. Assume that no resistive forces act on the system.

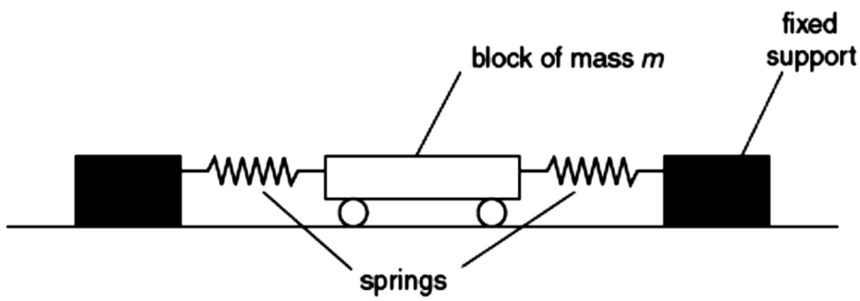

Fig. 7.2

(i) Both springs obey Hooke's Law and each has a spring constant k. The block is displaced a horizontal distance x and released.

By considering Newton's Laws, show that the initial acceleration a of the mass m is given by

$$a = -\frac{2kx}{m}$$

.

[2]

(ii) The mass oscillates with simple harmonic motion of frequency 3.2 Hz and amplitude 2.8 cm.

Determine the total energy of the oscillation.

total energy = ……………………… mJ [2]

(iii) At a particular instant, the kinetic energy of the mass is equal to the elastic potential energy of the springs. Calculate the distance from the equilibrium position at which this occurs.

distance = ………………….. m [3]

(iv) On Fig. 7.3, use your answers in **(d)(ii)** and **(d)(iii)** to sketch the variation with displacement x of

1. the total energy of the oscillation (label this graph T), [1]

2. the kinetic energy of the mass (label this graph K), [1]

3. the elastic potential energy of the springs (label this graph P). [1]

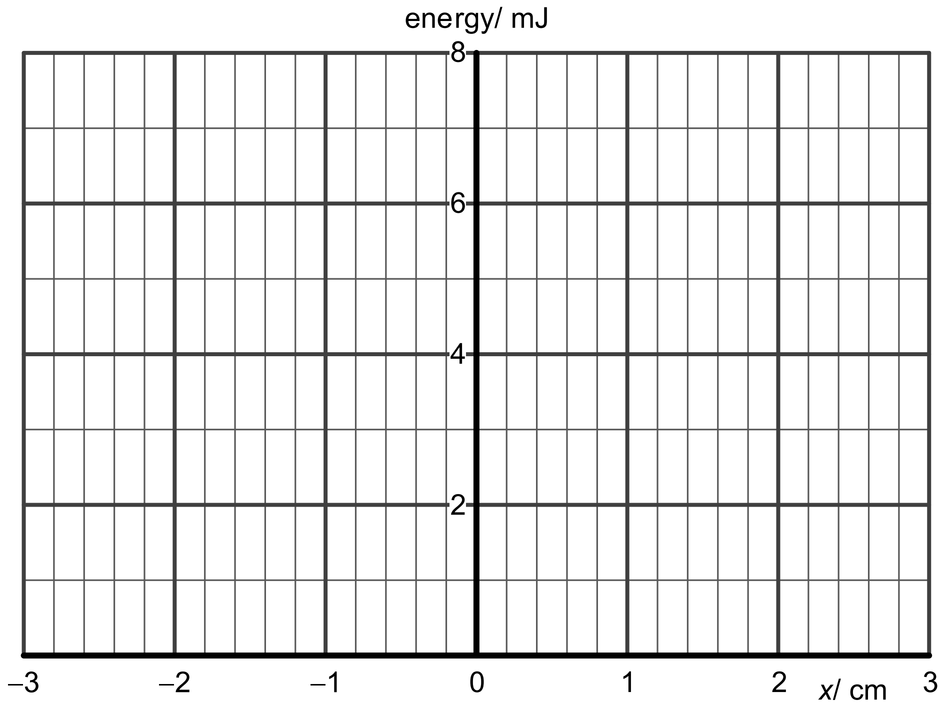

Fig. 7.3

(e) The system in Fig. 7.2 is now rearranged such that mass *m* oscillates vertically on only one of the springs, as shown in Fig. 7.4.

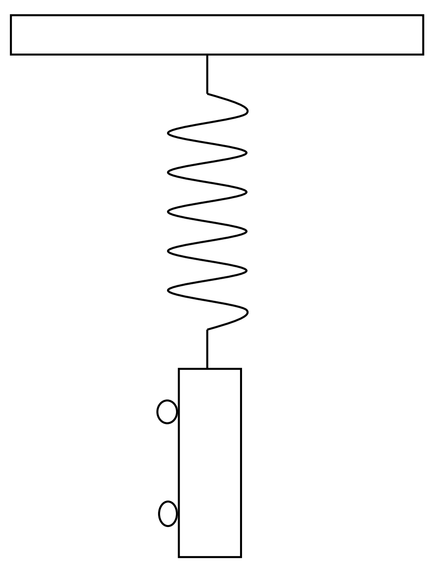

Fig. 7.4

By considering energy changes of the vertical spring-mass system, suggest and explain how the graphs in Fig. 7.3 would differ.

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

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

…………………………………………………………………………………………………….. [2]

[Total: 20]