1 **(a)** **(i)** On Fig. 3.1, draw a graph of extension against load for a spring which obeys Hooke's law. [1]

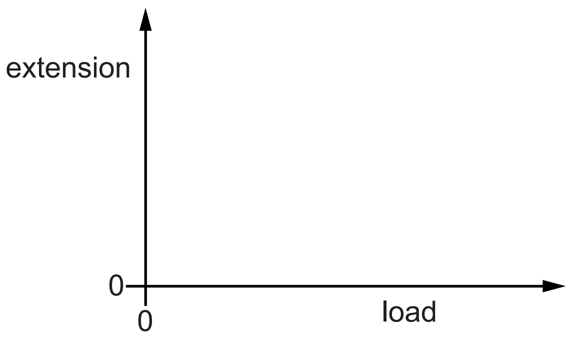

Fig. 3.1

(ii) State the word used to describe the energy stored in a spring that has been stretched or compressed.

....[1]

(b) Fig. 3.2 shows a model train, travelling at speed *v*, approaching a buffer.

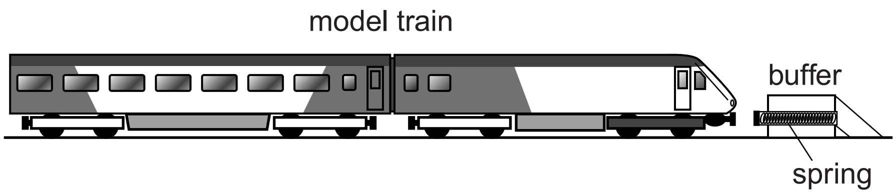

Fig. 3.2

The train, of mass 2.5 kg, is stopped by compressing a spring in the buffer. After the train has stopped, the energy stored in the spring is 0.48 J.

Calculate the initial speed *v* of the train.

v = ...[4]

[Total: 6]

2 An athlete of mass 64 kg is bouncing up and down on a trampoline.

At one moment, the athlete is stationary on the stretched surface of the trampoline. Fig. 3.1 shows the athlete at this moment.

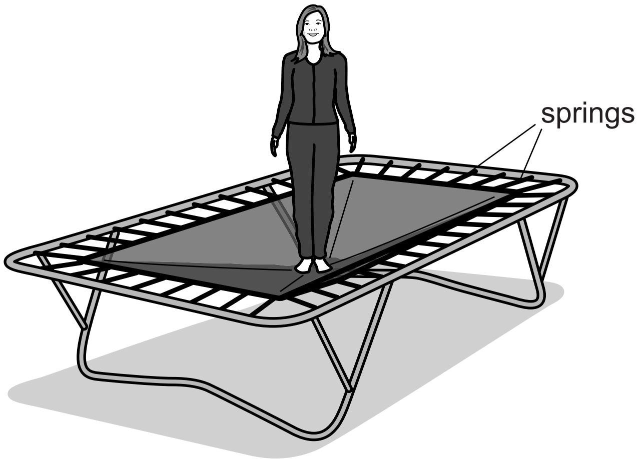

Fig. 3.1

(a) State the form of energy stored due to the stretching of the surface of the trampoline.

....[1]

(b) The stretched surface of the trampoline begins to contract. The athlete is pushed vertically upwards and she accelerates. At time *t*, when her upwards velocity is 6.0 m/s, she loses contact with the surface.

(i) Calculate her kinetic energy at time *t*.

kinetic energy = ...[2]

(ii) Calculate the maximum possible distance she can travel upwards after time *t*.

maximum distance = ...[3]

(iii) In practice, she travels upwards through a slightly smaller distance than the distance calculated in **(ii)**.

Suggest why this is so.

....

....[1]

(c) The trampoline springs are tested. An extension-load graph is plotted for one spring. Fig. 3.2 is the graph.

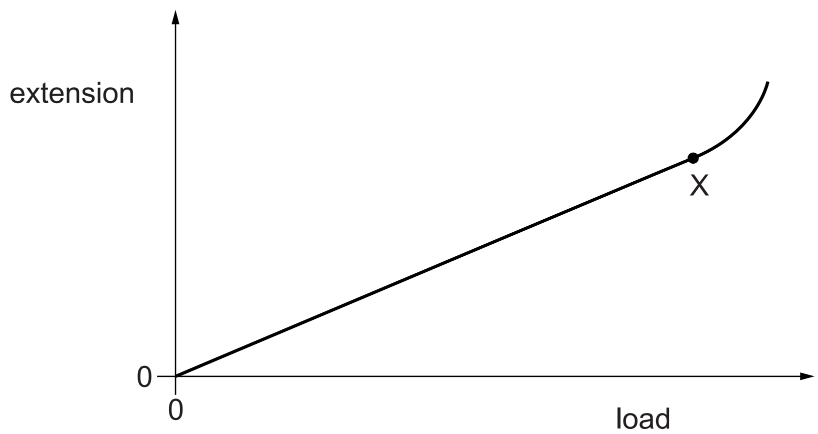

Fig. 3.2

(i) State the name of the point X.

....[1]

(ii) State the name of the law that the spring obeys between the origin of the graph and point X.

....[1]

[Total: 9]

3 Fig. 3.1 shows part of the extension-load graph for a spring.

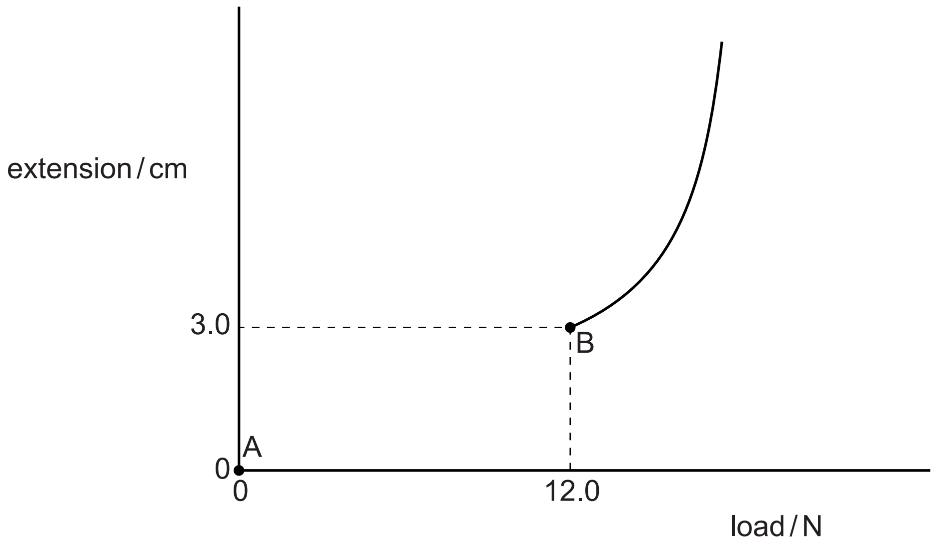

Fig. 3.1

The spring obeys Hooke's law between points A and B.

(a) **(i)** On Fig. 3.1, complete the graph between A and B. [1]

(ii) State the name of point B.

....[1]

(b) The average value of the load between A and B is 6.0 N.

Calculate the work done in extending the spring from A to B.

work done = ...[2]

(c) The spring has an unstretched length of 4.0 cm.

An object is hung on the spring and the spring length increases from 4.0 cm to 6.0 cm.

(i) Calculate the mass of the object.

mass = ...[3]

(ii) The object is immersed in a liquid but remains suspended from the spring.

The liquid exerts an upward force on the object and the length of the spring decreases to 5.0 cm.

Calculate the upward force exerted on the object by the liquid.

upward force = ...[2]

[Total: 9]

4 Fig. 2.1 shows the extension-load graph for a spring.

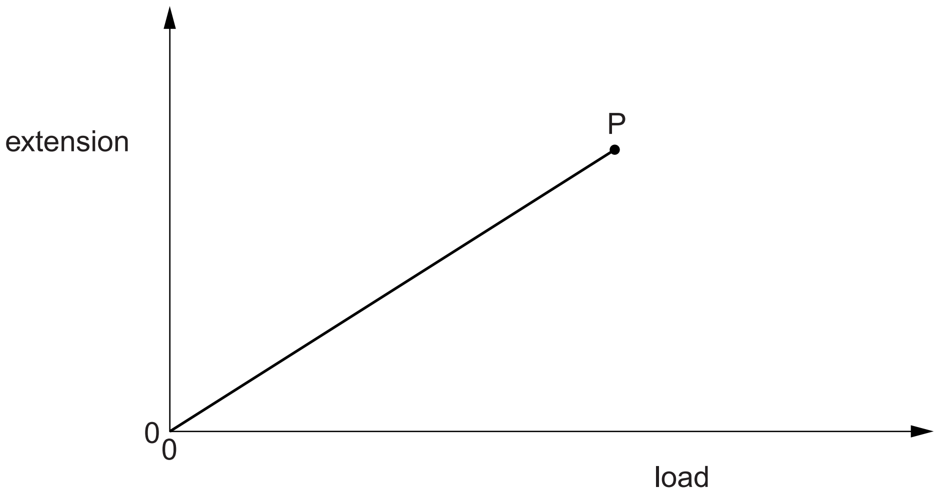

Fig. 2.1

Point P is the limit of proportionality.

(a) **(i)** Name the law obeyed by the spring from the origin to P.

.... [1]

(ii) Describe two features **of the graph** which show that the law is obeyed.

1. ....

2. ....

[2]

(b) On Fig. 2.1, sketch a possible continuation of the graph when the spring is loaded beyond the limit of proportionality. [1]

[Total: 4]

5 **(a)** State Hooke's law.

....

.... [1]

(b) Fig. 1.1 shows a graph of the stretching force *F* acting on a spring against the extension *x* of the spring.

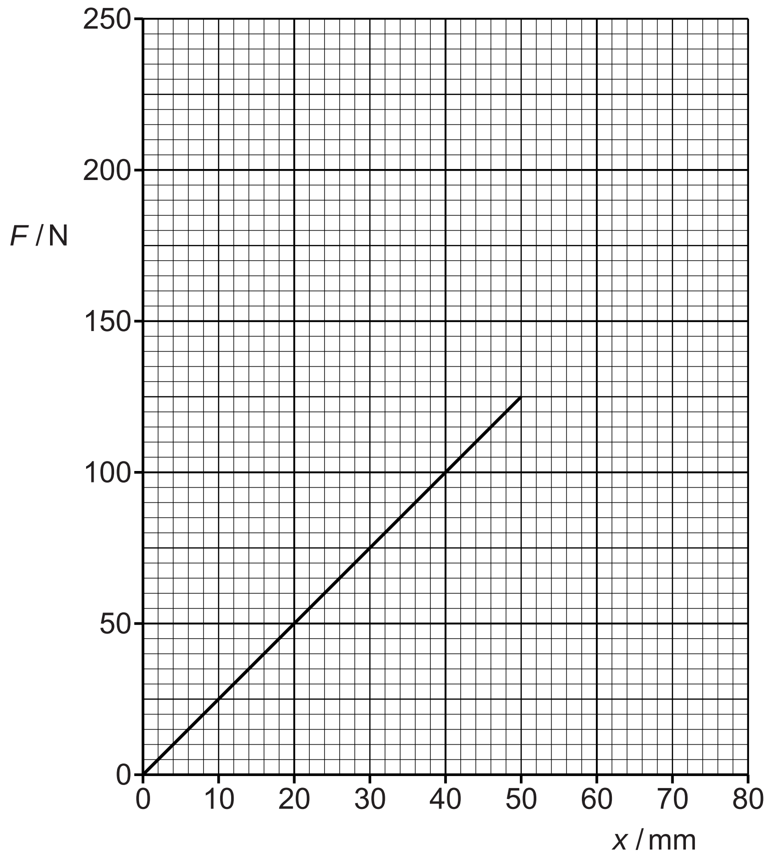

Fig. 1.1

(i) State the features of the graph that show that the spring obeys Hooke's law.

....

.... [1]

(ii) Calculate k, the force per unit extension of the spring.

k = ... [3]

(iii) The limit of proportionality of the spring is reached at an extension of 50 mm.

Continue the graph in Fig. 1.1 to suggest how the spring behaves when the stretching force is increased to values above 125 N. [1]

(iv) Another spring has a smaller value of k. This spring obeys Hooke's law for extensions up to 80 mm.

On the grid of Fig. 1.1, draw a possible line of the variation of F with x for this spring. [1]

[Total: 7]

6 A spring S is suspended from a clamp stand in a school laboratory.

A student hangs various masses from the end of S and determines the extension *x* produced by each mass.

(a) Calculate the weight of a 250 g mass.

weight = ... [2]

(b) The student plots a graph of the force *F* applied to the spring against the extension *x*. Fig. 2.1 is the student's graph.

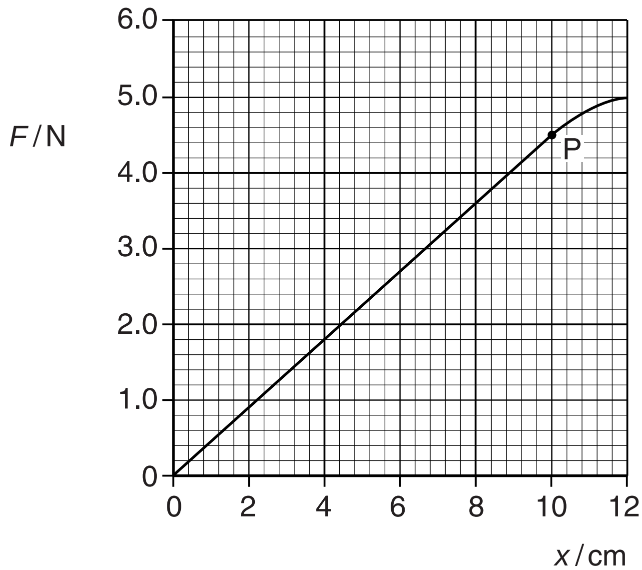

Fig. 2.1

At point P on the graph, the line begins to curve.

(i) State the name given to point P.

....

.... [1]

(ii) Use the section of the graph where spring S obeys Hooke's law ($F = kx$) to determine the spring constant k of the spring.

k = ... [2]

(c) Fig. 2.2 shows a mass of 0.12 kg resting on the bottom of a box.

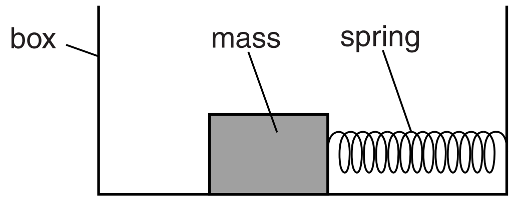

Fig. 2.2

A spring that is identical to S connects the mass and one side of the box. Ignore friction between the mass and the box.

(i) The box and the mass are at rest.

State the resultant force acting on the mass.

force = ... [1]

(ii) The box is firmly attached, in a horizontal position, to the body of a racing car.

As the car accelerates the spring stretches by 2.0 cm.

1. Using Fig. 2.1, determine the tension in the spring.

tension = ... [1]

2. Calculate the acceleration of the mass produced by this tension.

acceleration = ... [2]

[Total: 9]