Deformation of Solids

Question paper 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Deformation of Solids
Sub Topic	
Paper Type	Theory
Booklet	Question paper 2

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Explain what is meant by *plastic deformation*.

....

.... [1]

(b) A copper wire of uniform cross-sectional area $1.54 \times 10^{-6}\,m^2$ and length 1.75 m has a breaking stress of 2.20×10^{8} Pa. The Young modulus of copper is 1.20×10^{11} Pa.

(i) Calculate the breaking force of the wire.

breaking force = ... N [2]

(ii) A stress of 9.0×10^{7} Pa is applied to the wire. Calculate the extension.

extension = ... m [2]

(c) Explain why it is not appropriate to use the Young modulus to determine the extension when the breaking force is applied.

....

.... [1]

2 **(a)** With reference to the arrangement of atoms, distinguish between metals, polymers and amorphous solids.

metals: ....

....

polymers: ....

....

amorphous solids: ....

....
[3]

(b) On Fig. 3.1, sketch the variation with extension x of force F to distinguish between a metal and a polymer.

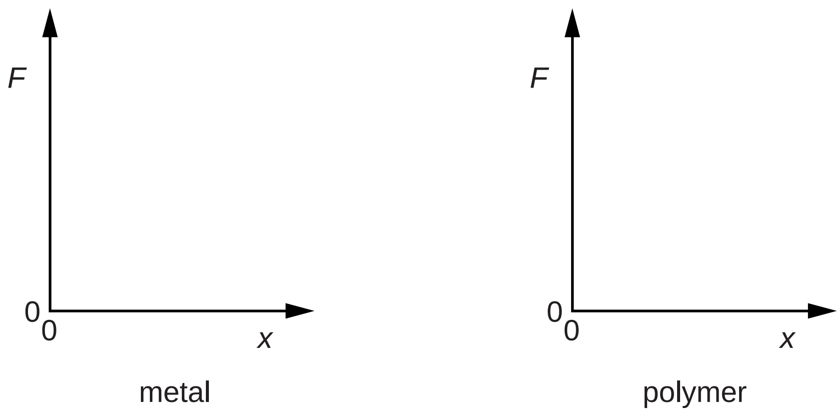

Fig. 3.1

[2]

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

....

....[1]

(b) A spring is attached to a support and hangs vertically, as shown in Fig. 6.1. An object M of mass 0.41 kg is attached to the lower end of the spring. The spring extends until M is at rest at R.

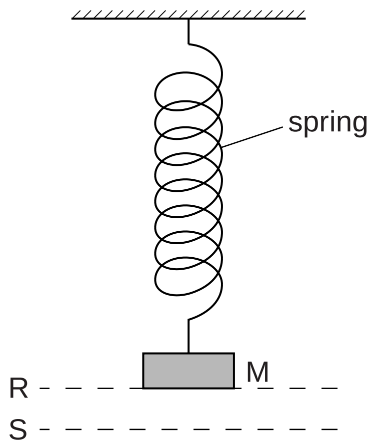

Fig. 6.1

The spring constant of the spring is 25 N m^{-1}. Show that the extension of the spring is about 0.16 m.

[2]

(c) The object M in Fig. 6.1 is pulled down a further 0.060 m to S and is then released. For M, just as it is released,

(i) state the forces acting on M,

....[1]

(ii) calculate the acceleration of M.

acceleration = ... m s^{-2} [3]

(d) Describe and explain the energy changes from the time the object M in Fig. 6.1 is released to the time it first returns to R.

....

....

....

....[2]

4 One end of a spring is fixed to a support. A mass is attached to the other end of the spring. The arrangement is shown in Fig. 3.1.

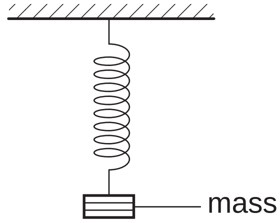

Fig. 3.1

(a) The mass is in equilibrium. Explain, by reference to the forces acting on the mass, what is meant by equilibrium.

....

....

.... [2]

(b) The mass is pulled down and then released at time t = 0. The mass oscillates up and down. The variation with t of the displacement of the mass d is shown in Fig. 3.2.

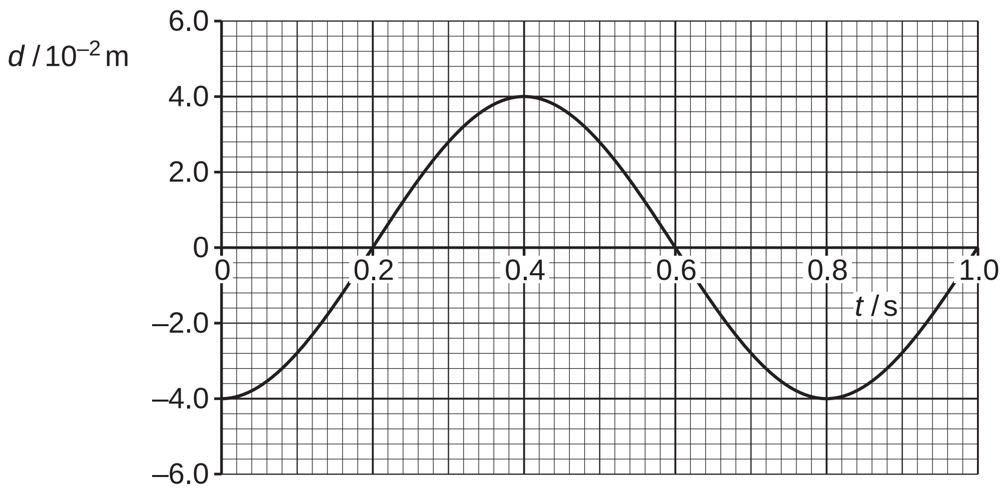

Fig. 3.2

Use Fig. 3.2 to state a time, one in each case, when

(i) the mass is at maximum speed,

time = ... s [1]

(ii) the elastic potential energy stored in the spring is a maximum,

time = ... s [1]

(iii) the mass is in equilibrium.

time = ... s [1]

(c) The arrangement shown in Fig. 3.3 is used to determine the length l of a spring when different masses M are attached to the spring.

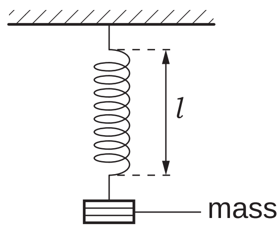

Fig. 3.3

The variation with mass M of l is shown in Fig. 3.4.

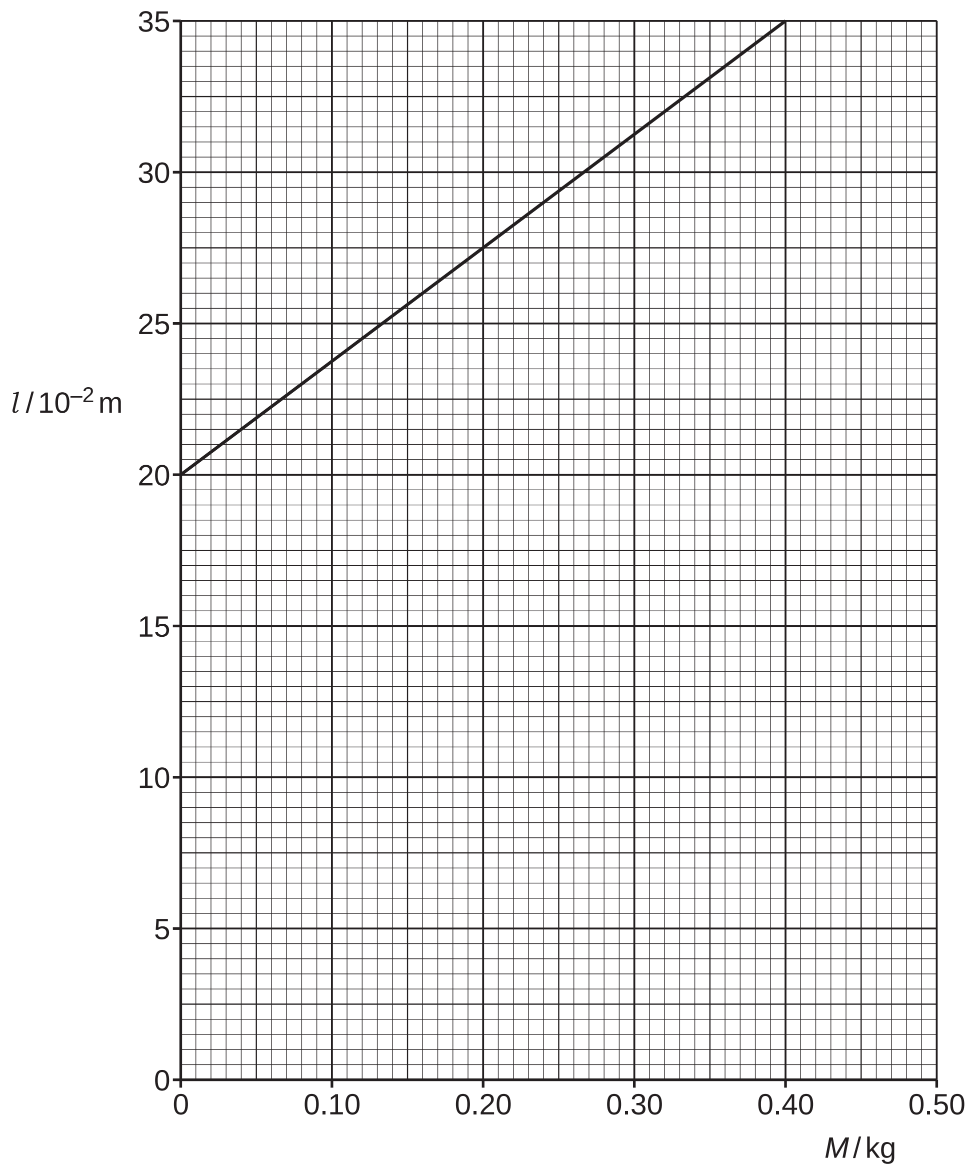

Fig. 3.4

(i) State and explain whether the spring obeys Hooke's law.

....

....

.... [2]

(ii) Show that the force constant of the spring is 26 N m^{-1}.

[2]

(iii) A mass of 0.40 kg is attached to the spring. Calculate the energy stored in the spring.

energy = ... J [3]

5 **(a)** Define the *Young modulus*.

....

.... [1]

(b) A load F is suspended from a fixed point by a steel wire. The variation with extension x of F for the wire is shown in Fig. 5.1.

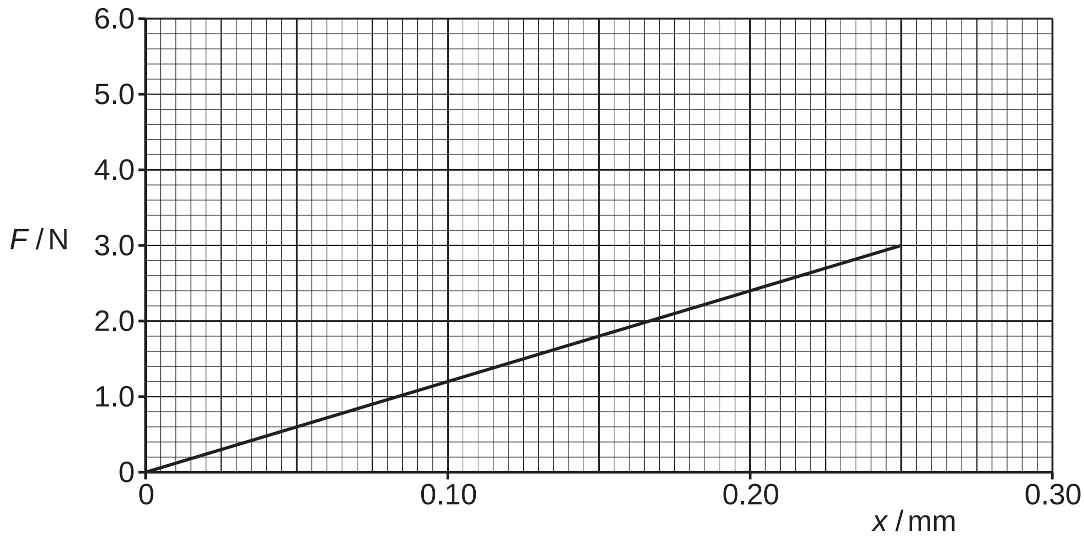

Fig. 5.1

(i) State two quantities, other than the gradient of the graph in Fig. 5.1, that are required in order to determine the Young modulus of steel.

1. ....

2. ....
[1]

(ii) Describe how the quantities you listed in **(i)** may be measured.

....

....

.... [2]

(iii) A load of 3.0 N is applied to the wire. Use Fig. 5.1 to calculate the energy stored in the wire.

energy = ... J [2]

(c) A copper wire has the same original dimensions as the steel wire. The Young modulus for steel is $2.2 \times 10^{11}\,\mathrm{N\,m^{-2}}$ and for copper is $1.1 \times 10^{11}\,\mathrm{N\,m^{-2}}$.

On Fig. 5.1, sketch the variation with *x* of *F* for the copper wire for extensions up to 0.25 mm. The copper wire is not extended beyond its limit of proportionality. [2]

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

....

.... [1]

(b) The variation with extension x of the force F for a spring A is shown in Fig. 6.1.

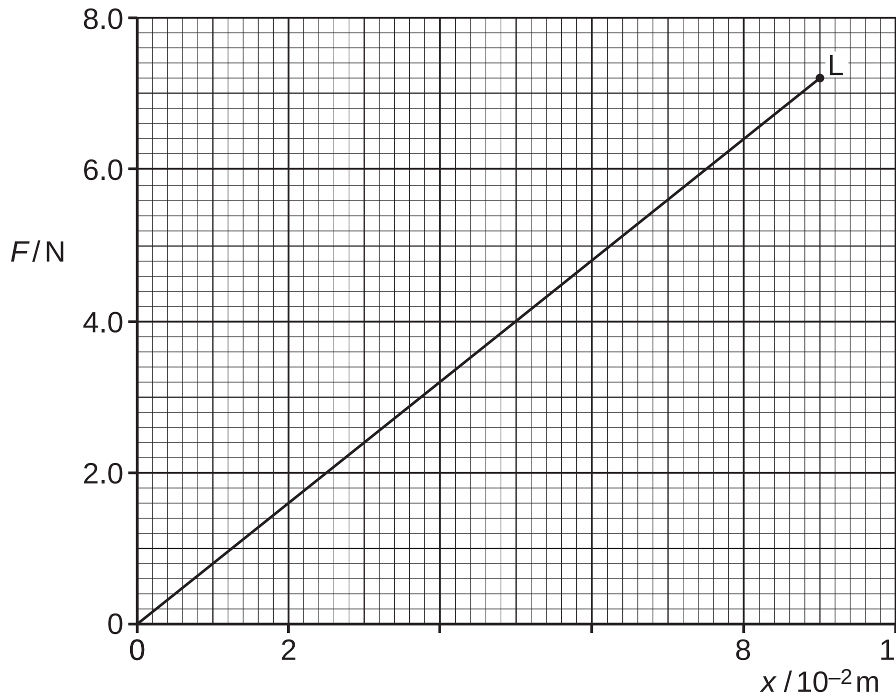

Fig. 6.1

The point L on the graph is the elastic limit of the spring.

(i) Describe the meaning of *elastic limit*.

....

....

.... [1]

(ii) Calculate the spring constant k_A for spring A.

k_A = ... $N m^{-1}$ [1]

(iii) Calculate the work done in extending the spring with a force of 6.4 N.

work done = ... J [2]

(c) A second spring B of spring constant $2k_A$ is now joined to spring A, as shown in Fig. 6.2.

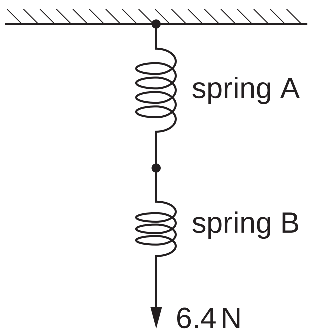

Fig. 6.2

A force of 6.4 N extends the combination of springs.

For the combination of springs, calculate

(i) the total extension,

extension = ... m [1]

(ii) the spring constant.

spring constant = ... N m^{-1} [1]