TUTORIAL QUESTIONS_DEFORMATION OF SOLIDS

Question 1

A wire is stretched by a force F which causes an extension L. The energy stored in the wire is ½ FL only if
a.) the extension of the wire is proportional to the force applied.
b.) weight of the wire is negligible.
c.) the wire is not stretched beyond its elastic limit.
d.) the acceleration of free-fall is constant.
e.) the cross-sectional area of the wire remains constant.

Question 2

A wire that obeys Hooke's law is of length x_1 when it is in equilibrium under a tension T_1. Its length becomes x_2 when the tension is increased to T_2. What is the extra energy stored in the wire as a result of this process?
a.) ¼ $(T_2 + T_1)(x_2 - x_1)$
b.) ¼ $(T_2 + T_1)(x_2 + x_1)$
c.) ½ $(T_2 + T_1)(x_2 - x_1)$
d.) ½ $(T_2 + T_1)(x_2 + x_1)$
e.) $(T_2 - T_1)(x_2 - x_1)$

Question 3

A force of 10 N acting on a certain spring gives an extension of 40 mm. Two such springs are connected end to end and this double length spring is extended by 40 mm. Assuming that the springs conform to Hooke's law, what is the strain energy.
a.) 0.05 J b.) 0.10 J c.) 0.20 J d.) 0.40 J e.) 0.80 J

Question 4

A load of 6.0 N is placed on a spring that obeys Hooke's law is a given an extension of 0.03 m. What additional strain energy will be stored in the spring if it is extended a further 0.01 m?
a.) 0.010 J b.) 0.060 J c.) 0.070 J d.) 0.160 J e.) 0.220 J

Question 5

A spring obeying Hooke's law has an unstretched length of 50 mm and a spring constant of 400 Nm^{-1}. What is the tension in the spring when its overall length is 70 mm?
a.) 8.0 N b.) 28 N c.) 160 N d.) 400 N e.) 480 N

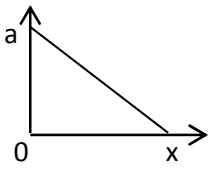
Question 6

A wire is stretched by a force F which causes an extension x. If the wire were to cut in half, what would be the force constant K' of one of the pieces in terms of the force constant K of the original wire?

Question 7

A door is fitted with a spring-operated latch. The latch is well oiled so friction is negligible. When the latch is pushed in, the spring becomes compressed but remains within its elastic limit. The latch is then suddenly released. Which graph best shows how the acceleration a, of the latch varies with the distance x, it moves before it is stopped?

a.)



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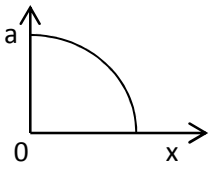

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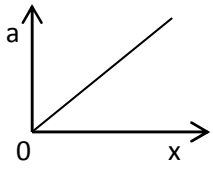

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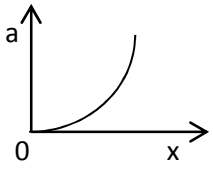

Question 8

A catapult consists of two strands of rubber, each of unstretched length 0.20 m and each of which stretches by 0.1 m under the tension of 50 N. A stone of mass 0.060 kg is projected vertically upwards from the catapult after each strand has been extended to a total length of 0.35 m.

a.) What is the energy stored in the stretched catapult?

b.) Find the maximum height attained by the stone. (take g = 10 ms^{-2})

Question 9

A spring A with force constant 6 Nm^{-1} is connected in series with a spring B of force constant 3 Nm^{-1}. One end of the combination is securely anchored and a force of 0.6 N is applied to the other end.

a.) By how much does each spring extend?

b.) What is the force constant of the combination?

c.) What is the total strain energy stored?

Question 10

A thick rubber cord is fixed firmly at one end. A 5.0 kg mass is attached to the lower end, causing an equilibrium extension of 20 mm. The rubber obeys Hooke's law over this extension.

a.) Find the change in gravitational potential energy of the mass as a result of the extension.

b.) How much energy is stored in the rubber?

c.) How do you reconcile your answers to (a) and (b) with the principle of conservation of energy?

Question 11

The spring constant k of a spring may be determined by finding the extension of the spring and the load applied. A student obtained the following readings when conducting the experiment.

Reading on the ruler for the lower end of the unextended spring = 13.60 ± 0.05 cm
Reading on the ruler for the lower end of the extended spring = 17.95 ± 0.05 cm
Load = 4.00 ± 0.02 N

It may be assumed that the spring obeys Hooke's law.
a.) Calculate the percentage uncertainty in the determination of k.
b.) Calculate k and give it with its actual uncertainty to the appropriate number of s.f.
c.) What is the percentage uncertainty in the determination of the extension of the spring if the measurements made are obtained with a load of 2.00 N?

Question 12

A light spring of unextended length 14.2 cm is suspended vertically from a fixed point, as illustrated in Fig. 4.1

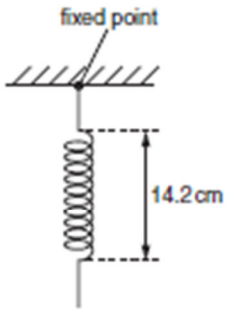

Fig. 4.1

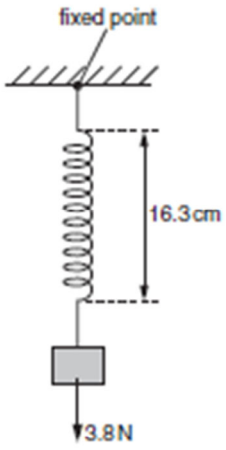

Fig. 4.2

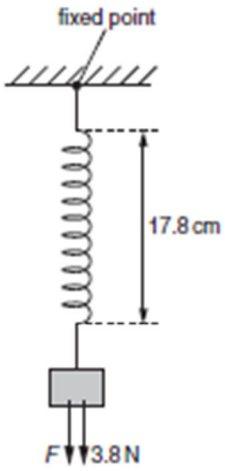

Fig. 4.3

A mass of weight 3.8 N is hung from the end of the spring, as shown in Fig. 4.2. The length of the spring is now 16.3 cm.

An additional force *F* then extends the spring so that its length becomes 17.8 cm, as shown in Fig. 4.3.

The spring obeys Hooke's law and the elastic limit of the spring is not exceeded.

(i) Show that the spring constant of the spring is 1.8 N cm^{-1}
(ii) For the extension of the spring from a length of 16.3 cm to a length of 17.8 cm,

1. calculate the change in the gravitational potential energy of the mass on the spring,
2. show that the change in elastic potential energy of the spring is 0.077 J,
3. determine the work done by the force *F*.

Question 13

Material	E / Pa	Breaking stress / Pa	Cross-sectional area / 10^{-4} m^2	Breaking force / N
Steel	2.0×10^{11}	9×10^{8}	1.0	9×10^{4}
Nylon	7.0×10^{7}		5.0	3×10^{4}
X	1.1×10^{11}	5×10^{8}		1×10^{4}
Y	5.5×10^{10}	1×10^{9}	0.2	

A.) Fill up the missing data in the table.
B.) Arrange the materials in decreasing order of stiffness.
C.) Arrange in increasing order of strength.
D.) Which rope / fibre will be the first to break when load is gradually increased, and what is the value of the least force to break it?
E.) Which rope requires the greatest force to break it?
F.) Label each graph below according to the above material.
G.) Describe the property of each material with a suitable term.