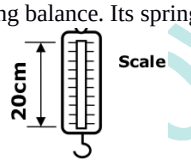
7. HOOKE'S LAW

1. State **Hooke's** law
2. Define the term elastic limit, as used in stretching of materials
3. State the **SI** units of elastic constant of a spring
4. State the features that govern the strength of a spiral spring of a given material.
5. State two factors on which the extension of a wire depends on assuming it obeys Hooke's Law.
6. Apart from the diameter and length, name another factor that determine the spring constant of a spiral spring.
7. A heavy load is suspended on a wire. Give any one factor that will determine extension in the wire.
8. Distinguish between ductile end and brittle material
9. It is easier to bend an iron rod than a glass rod of the same dimensions at room temperature. Give a reason for this
10. A spiral spring stretches by **0.6 cm** when a mass of **300 g** is suspended on it. What is the spring constant? ***ANS 500 N/m***
11. An unloaded spring has a length of **15cm** and when under a load of **24 N** it has a length of **12 cm**. What will be the load on the spring when length is **10 cm**? ***ANS 40 N***
12. An object of weight **20 N** attached at the end of a spring causes an extension of **0.5 cm** on the spring.
    (a) Determine the spring constant. ***ANS 4000 N/m***
    (b) Determine the weight of an object that would cause an extension of 0.86 cm on the same spring. ***ANS 34.4 N***
13. A copper wire is **2 m** long. A force of **4 N** suspended on the wire while other end is fixed increases its length to **2.001 m**. **What** force would make the length of the wire **2.032 m**? ***ANS 128 N***
14. The pointer of an unloaded spring reads **32 cm**. when a mass of **120 g** is applied to the spring, the pointer reads **38 cm**. a pan in which a mass of **210 g** is placed is now hang from the spring and the pointer reads **48 cm**. determine the mass of the pan. ***ANS 0.11 kg***
15. Two identical helical springs are connected in series. When a **50g** mass is hang at the end of the springs, it produces an extension of **2.5 cm**. Determine the extension produced by the same mass when the springs arc connected in parallel. ***ANS 0.625 cm***
16. Two springs of negligible weights and spring constants 50 N/m and 75 N/m respectively are connected in series and suspended from a fixed point. Determine the total extension when a mass of 7.5 kg is hung from the lower end. ***ANS 2.5 m***
17. Two springs of negligible weight and of spring constants **100 Nm $^{-1}$** respectively are connected end to end and suspended from a fixed point. Determine;
    (i) The total extension when a mass of **7.5 kg** is hung from the lower end. ***ANS 1.5 m***
    (ii) The elastic constant of the combined of springs. ***ANS 50 N/m***
18. A spring extends by 6 cm when supporting a mass of 0.06 kg on earth. When the spring is used to support the same mass on the moon, it extends by 1 cm. determine the moons gravitational strength. (*take the gravitational field strength on earth as 10 N/kg*) ***ANS 1.667 N/kg***

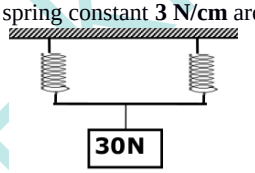
SPRINGS

1. The figure below shows a spring balance. Its spring constant is 125 Nm^{-1}. The scale spreads over a distance of 20cm.



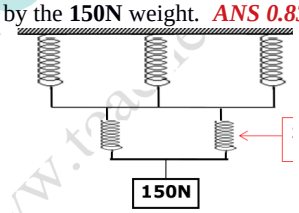
Determine the maximum weight that can be measured using this spring. ***ANS 25 N***

2. The identical springs of spring constant **3 N/cm** are used to support a load of **30 N** as shown.

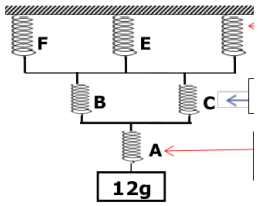


Determine the extension on each spring ***ANS 5 cm or 0.05 m***

3. The spiral springs shows in the figure below are identical. Each spring has a spring Constant **K=100 N/m** Determine the total extension caused by the **150N** weight. ***ANS 0.8333 m***

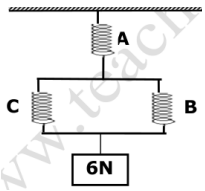


4. Figure shows a mass of **12 g** suspended on a set of **6** identical springs. When the mass was hanged on spring **A**, it extended by 5cm.



Determine the extension of the combination shown if each spring and rod has negligible weight. ***ANS 0.09167 m or 9.167 cm***

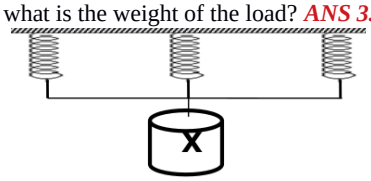
5. Three identical springs each of spring constant 10 N/m and weight 0.5 N are used to support a load as shown. Determine the total extension of the system



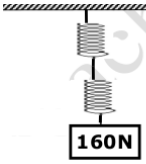
6. A light spring fixed at one end extends by 2.0 cm when a weight of 120 g is suspended from the free end .

(i) Find its spring constant. ***ANS 60 N/m***

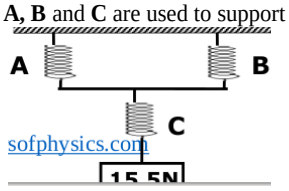
(ii) Three such springs are arranged in a manner shown in figure below and used to support a load If each extends by 2.0 cm, what is the weight of the load? ***ANS 3.6 N***



7. Two springs of negligible weight and elastic constants of **800 N/m** and **400 N/m** are arranged as shown below with a load of **160 N** supported at the bottom. Calculate the total extension of the springs. ***ANS 0.6 m***

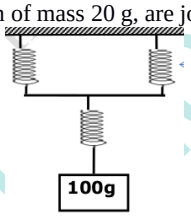


8. Three identical springs **A, B** and **C** are used to support a **15.5 N** weight as shown in the figure below. ***ANS***



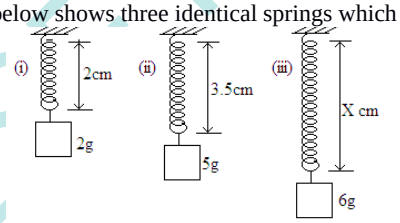
If the weight of the horizontal beam is **0.5 N**, determine the extension of each spring given that **4 N** causes an extension of **1 cm**.

9. Three identical springs, each of mass 20 g, are joined together as shown below and support a mass of 100 g.



If the spring constant of each spring is **500 N/m**, calculate the combined spring constant of the set-up.

10. The diagram below shows three identical springs which obey Hooke's law.

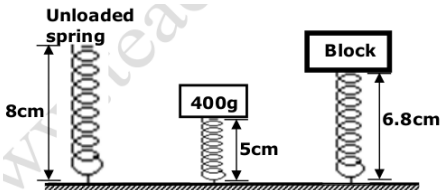


Determine the length **X**. ***ANS 0.04 m or 4 cm***

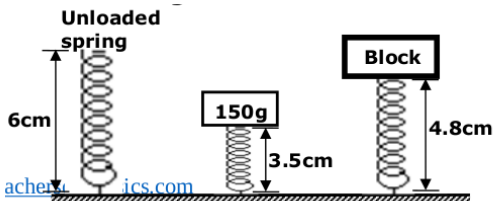
11. Figure shows a spiral spring fixed on a bench vertically. A mass of **0.5 kg** is placed on top as shown in the figure below.

In **(a)** the height of the spring is **6 cm** while in **(b)** the height is **4 cm**. find the energy stored in the spring in figure **(b)** ***ANS 0.05 J***

12. The diagram below shows the same spring in three different situations; when unloaded, when supporting a load of **400 g** and when supporting a wooden block. Find the mass of the wooden block. ***ANS 0.16 kg***



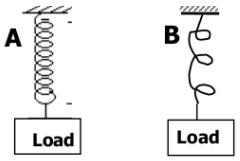
13. The diagram in figure below shows unloaded spring, when supporting a load of **150 g** and a wooden block.



Find the mass of the wooden block ***ANS 0.072 kg***

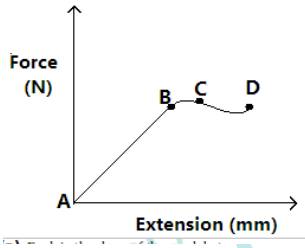
GRAPH SKETCHES

1. The figure below shows two springs **A** and **B** made of same material, same diameter and same length but with different number of turns.



Sketch a graph of load against extension for each. (*Hooke's law is obeyed*)

2. The graph in the figure below was obtained when suitable weights were suspended from a spiral spring and extensions measured



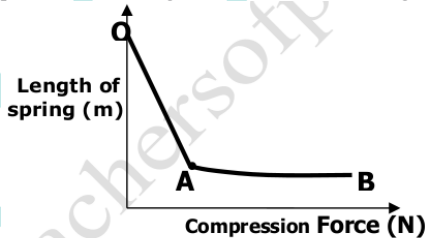
(a) Explain the shape of the graph between

(i) **AB**

(ii) **CD**

(b) Two identical spiral springs are then arranged in parallel and the weights suspended. on the same axes above, sketch the graph that would now be obtained

3. Use the graph below showing the variation of the length of a spring and the compressional force applied on it to answer questions



(i) State the significance of the point labelled A.

(ii) Explain the nature of the graph between A and B.

TABLES

1. The table below shows the value of extensions of a spiral spring when various forces are applied.

Force F(N)	**0**	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**
Extension e(cm)	**0**	**0.8**	**1.6**	**2.4**	**3.2**	**4.0**	**4.8**

a) Plot a graph of force (y – axis) against the extension.

b) Determine the work done in stretching the spring by **2.7 cm**; using the graph. ***ANS 0.046 J***

c) Determine the spring constant of the spring. Give your answer in **SI** units. ***ANS 125 N/m***

2. The table below shows the values of extensions of a spiral spring when various forces were applied on it.

Force, F (N)	**0.0**	**1.2**	**2.0**	**3.6**	**4.0**	**4.8**	**6.0**
Extension, e (cm)	**0.0**	**0.8**	**1.3**	**2.5**	**2.7**	**3.2**	**4.0**
Extension (e) (m)							

i) Plot a graph of extension in metres (y-axis) against force (x-axis).
ii) Use the graph to determine the spring constant of the spring. ***ANS 150N/m***
(iii) Determine the work done in stretching the spring by **4.5 cm**. ***ANS 0.1519 J***

3. The following results were obtained in an experiment to verify Hooke's law when a spring was extended by hanging various loads on it.

Load, L(N)	**0.00**	**1.00**	**2.00**	**3.00**	**4.00**	**5.00**	**6.00**
Length of spring (cm)	**10.00**	**11.50**	**13.00**	**14.50**	**16.00**	**18.50**	**24.00**
Extension, e (cm)	**0.00**						

i) Complete the table for extension, e, above
ii) Plot a graph of Load (y-axis) against extension.
ii) From the graph, determine the spring constant, k. ***ANS 88.89 N/m***

4. A student carried out an experiment to investigate the relationship between the force and extension produced on a spiral spring. He tabulated his results as shown below.

Force (N)	**0**	**0.8**	**1.5**	**3.0**	**4.5**	**6.0**	**7.5**
Extension (cm)	**0**	**0.50**	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**

(i) Plot a graph of extension in cm in the y-axis against force in N
(ii) Determine the spring constant. ***ANS 1.5 N/cm***
(iii) What force would be required to produce an extension of 2.5 cm ***ANS 3.7 N***
(iv) What extension is produced by:
(a) A force of **5.5 N** ***ANS 3.8 cm***
(b) A mass of **700 g**

5. The table below has a data recorded for a compressional force on a spring balance.

Force F (N)	**0**	**5.0**	**10**	**15**	**17.5**	**22.5**	**35.0**	**40**	**4**	**50**
Length of spring L (cm)	**16.5**	**15.0**	**13.5**	**12**	**11.6**	**9.75**	**8.25**	**8**	**8**	**8**
Compression of spring e (cm)										

i) Complete the table for the values of compression **(e)**
ii) Plot a graph of extension (vertical axis) versus force applied on the spring (horizontal axis). From your graph determine.
iii) The spring constant **K**. ***ANS 3.333 N/cm or 333.3 N/m***
iv) Work done in compressing the spring until the coils just come into contact. ***ANS 0.7481 J***

6. a) A spring with its upper end fixed, hang vertically and several masses are suspended from its lower end one at a time. The readings were recorded as shown.

Mass in kg	**0**	**0.02**	**0.04**	**0.06**	**0.08**	**0.10**
Extension (mm)	**110**	**121**	**129**	**139**	**151**	**161**
Force N						
Extension in m						

i) Fill in the table
ii) Plot a graph of extension in (m) against force in N.

b) (i) From the graph determine the extension of a mass **0.045 kg**. Give your answer in ***mm*** ***ANS***
(ii) Determine the spring constant of the spring ***ANS***

c) If two such springs were connected in series what extension would they show when a mass of **1.5 kg** hangs from one end?