

# TEACHER NOTES

## Hooke's Law Program

### Robert Hooke 1635-1703 *(see [Encarta](#))*

*This program is designed to be used with standard springs available from equipment distributors such as Philip Harris that will be a 'hands on' version of the program. To investigate Hooke's Law not being obeyed, elastic bands can be used to produce a non-linear graph.*

#### Quiz Answers

| No. | Answer  | Description   |
|-----|---------|---|
| 1   | 2(B)    | <i>Hooke's Law Definition</i>   |
| 2   | 3(C)    | <i>Accuracy to the nearest millimetre</i>                             |
| 3   | 4(D)    | <i>100 g <math>\equiv</math> 1 N using <math>W = mg</math></i>        |
| 4   | 1(A)    | <i>Halve the load, halve the extension</i>                            |
| 5   | 4(D)    | <i><math>K = F/x</math> rearranging equations and magic triangle</i>  |
| 6   | 2(B)    | <i>500 g <math>\equiv</math> 5 cm extension, hint shows the graph</i> |
| 7   | 1(A)Yes | <i>Possible to exceed the elastic limit</i>                           |
| 8   | 4(D)    | <i>1kg <math>\equiv</math> 10 N using <math>W = mg</math></i>         |
| 9   | 3(C)    | <i>To triple extension, load must be tripled</i>                      |
| 10  | 1(A)Yes | <i>If spring undamaged, it will return to its original position</i>   |

#### Notes

*The quiz works well if you go round the class asking students individually. If they all find a question difficult, they can vote.*

#### Discussion

What everyday objects obey/do not obey Hooke's Law?

| Obey   | Do Not Obey  |
|--|--------------|
| Spring balance   | Plastic bags |
| Car suspension   | Plasticene   |
| Springs inside machines such as videos and washing machines  | Elastic      |
| Canteen dinner-plate dispenser (as a plate is removed, the remaining plates move up the required amount) | Putty        |
| Anglepoise reading lamp  |              |

# Hooke's Law Worksheet

## 1. Define Hooke's Law

*Provided the elastic limit has not been exceeded, the extension is directly proportional to the load.*

*(Mouse-over Hooke's Law on the first screen brings up the definition)*

## 2. Use the program to fill in the values

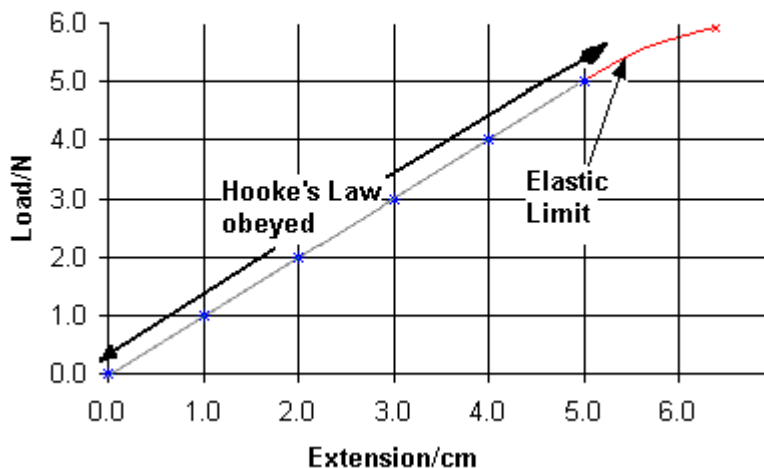
| Load/N | Extension/cm |
|--------|--------------|
| 0.0    | 0.0          |
| 1.0    | 1.0          |
| 2.0    | 2.0          |
| 3.0    | 3.0          |
| 4.0    | 4.0          |
| 5.0    | 5.0          |
| 6.0    | 6.4          |

**NB Hooke's Law no longer obeyed.**

## 3. Now try plotting a graph of Load against Extension

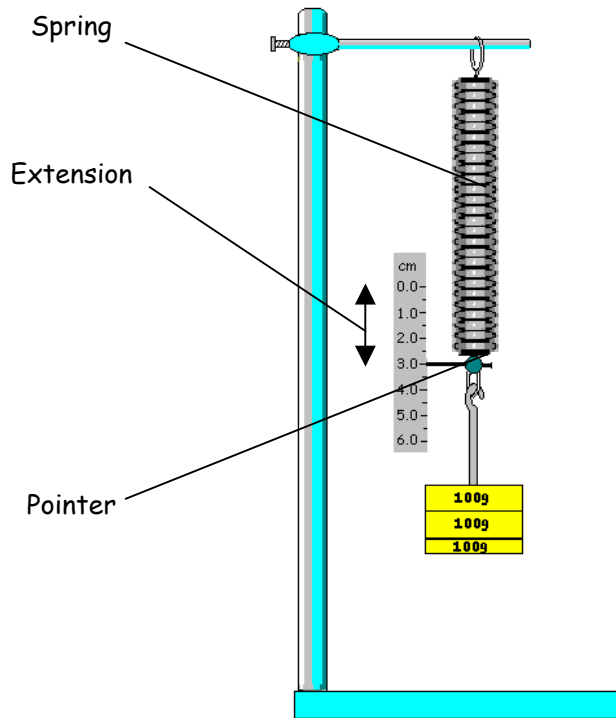
*The gradient gives a value for  $k$  and the steeper the line, the stronger the spring. Could discuss why the graph is drawn this way round as some textbooks draw it with the variable along the X-axis. Weaker students could have a simple grid with axes photocopied for them. The finer points of elastic limits and limits of proportionality are normally beyond the scope of the GCSE syllabus and the average student.*

A Graph of Load Against Extension



# Hooke's Law Experiment

## Diagram



## Method

*Set up the apparatus as shown, but with no load. Try and arrange for the pointer to be exactly on zero, this makes it easy for the extension to be measured as each 50 or 100 g mass is added. Next carefully add fifty or one hundred gram masses and record the extension each time. More able students could also investigate the extension during unloading to see if the spring has been permanently stretched.*

## Results

| Mass/g | Extension/cm |
|--------|--------------|
| 0.0    | 0.0          |
| 100    |              |
|        |              |
|        |              |
|        |              |
|        |              |
|        |              |
|        | Etc.         |

## Graph

*Draw a graph of load against extension.*

## Conclusion

*Is Hooke's Law obeyed?*

## Hooke's Law Problems/Homework/Test

Take  $g = 10 \text{ m/s}^2$  and use  $F = kX$

1. A spring extends by 10 cm when a mass of 100 g is attached to it. What is the spring constant?

Using  $F = kx$  hence  $k = F/x = 100/10 = \underline{10 \text{ g/cm}}$

2. What will be the extension of this spring if the load is 75 g?

$X = F/k = 75/10 = \underline{7.5 \text{ cm}}$

3. If an identical spring were connected in parallel (do a sketch), what mass would need to be attached to produce an extension of 15 cm?

*Double spring becomes twice as strong/stiff so  $k'$  becomes 20 g/cm, and gradient in sketch of Load against Extension doubles in value.*

*(Think of a chest expander)*

*Using  $F = k'x = 20 \times 15 = \underline{300 \text{ g}}$*

4. What mass would be needed if two of these springs were placed in series (do a sketch) and an extension of 30 cm was required?

*Gradient in sketch of Load against Extension halves in value, spring now becomes half as strong/stiff so  $k'' = 5 \text{ g/cm}$*

*$F = k''x = 5 \times 30 = \underline{150 \text{ g}}$*

5. What is the weight of this mass?

*Using  $W = mg$   
 $= 0.150 \times 10$   
 $= \underline{1.5 \text{ N}}$*