CAMBRIDGE IGCSE™ PHYSICS 0625 | TOPIC 1.5

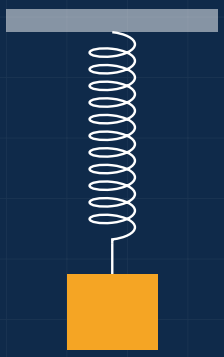
FREE SAMPLE

Forces

Free sample: knowledge organiser and Worksheet 1 with answers

Springs & extension | Resultant force | Friction & drag | F = ma | Moments

Centre of gravity | Exam-style questions



$$F = ma$$



$$k = F / x$$

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Free sample

Full pack: worksheets, exam paper, answers

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Knowledge organiser

Key words

Resultant force – the single force that has the same effect as all the forces acting together.

Friction – force between surfaces that impedes motion and produces heating; in a liquid or gas it is **drag** (air resistance in air).

Moment – the turning effect of a force about a pivot.

Equilibrium – no resultant force *and* no resultant moment.

Centre of gravity – the point through which the weight of an object acts.

Equations

moment $= F \times d$ unit N m

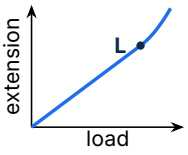
d is the perpendicular distance from the pivot

SUPPLEMENT $k = F/x$ spring constant unit N/m

SUPPLEMENT $F = ma$ F is the resultant force

Principle of moments: for a balanced object, sum of clockwise moments = sum of anticlockwise moments.

Springs: load–extension graph



Extension = stretched length − unstretched length.

Straight line through the origin: extension $\propto$ load.

SUPPLEMENT L is the **limit of proportionality**: beyond it the line curves.

Resultant force and motion

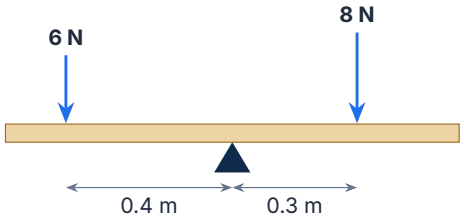
Forces along one line: add those in the same direction, subtract opposite ones.

Resultant force zero: object stays at rest *or* moves at constant speed in a straight line.

Resultant force not zero: speed and/or direction changes.

SUPPLEMENT Acceleration is in the direction of the resultant force.

Moments and balance



Anticlockwise: $6 \times 0.4 = 2.4$ N m. Clockwise: $8 \times 0.3 = 2.4$ N m. Equal, so it balances.

SUPPLEMENT With several forces on one side, add their moments.

Centre of gravity and stability

Finding it (flat shape): hang the shape from a pin so it swings freely; hang a plumb line from the pin and draw along it. Repeat from a second hole. The centre of gravity is where the lines cross.

Stability: a low centre of gravity and a wide base. An object topples when the vertical line through its centre of gravity falls outside its base.

SUPPLEMENT Moving in a circle

A force towards the centre, at right angles to the motion. A **larger force** is needed for a higher speed or a larger mass (radius unchanged). Same mass and speed: larger force, smaller radius.

Worked example

A boy of weight 450 N sits 1.2 m from the pivot of a see-saw. Where must his sister (360 N) sit to balance it?

$450 \times 1.2 = 360 \times d$

$d = 540 \div 360 = 1.5$ m on the other side.

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Interactive simulations

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1.5.1 EFFECTS OF FORCES

Stretching a Spring

Add masses to a spring, measure the extension and find the limit of proportionality.

Use with: Worksheet 1: Springs and stretching

benfizikyapamiyorum.com/icdp/forces-spring.html

Scan or click

1.5.2 TURNING EFFECT OF FORCES

Balance the Beam: Moments

Drag weights onto a pivoted beam and balance the clockwise and anticlockwise moments.

Use with: Worksheet 3: Moments

benfizikyapamiyorum.com/icdp/forces-moments.html

How to get the most from them Make a prediction first, then test it in the simulation. Change one thing at a time and note what happens to the readings. Each simulation ends with a quick *Check yourself* question.

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Springs and stretching

WORKSHEET 1

CORE SUPPLEMENT

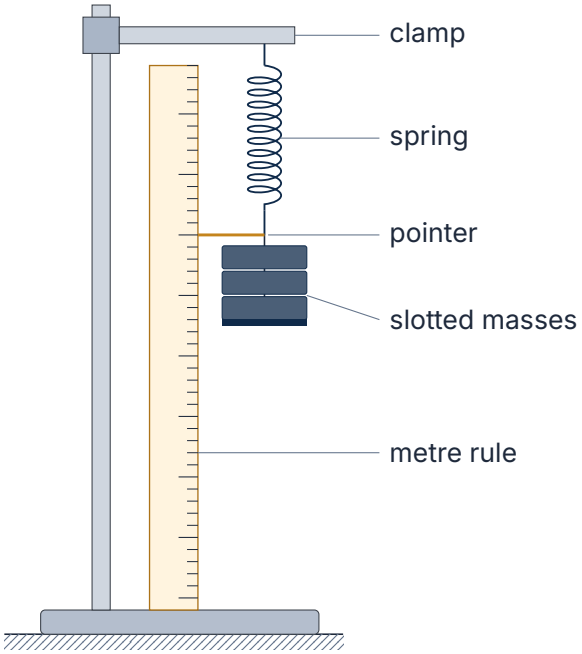
You will: describe how forces change the size and shape of objects, carry out and analyse a spring experiment, and (Extended) use the spring constant and the limit of proportionality.

CORE all students SUPPLEMENT Extended (Supplement) students CHALLENGE stretch question

1 CORE Forces can change the motion of an object. State **one** other effect that a force can have on an object. [1]

.....

2 CORE A student investigates how the extension of a spring depends on the load hung from it. The diagram shows her apparatus.



(a) Describe how she uses the metre rule to find the **extension** of the spring for each load. [2]

.....

.....

(b) State **two** things she should do to make her readings accurate. [2]

.....

.....

3 CORE **Spot the mistake.** A spring is 5.0 cm long. When a load is hung from it, its length becomes 8.2 cm. A student writes: *"The extension is* 8.2 cm." Explain the mistake and give the correct extension. [2]

.....

.....

extension = _____

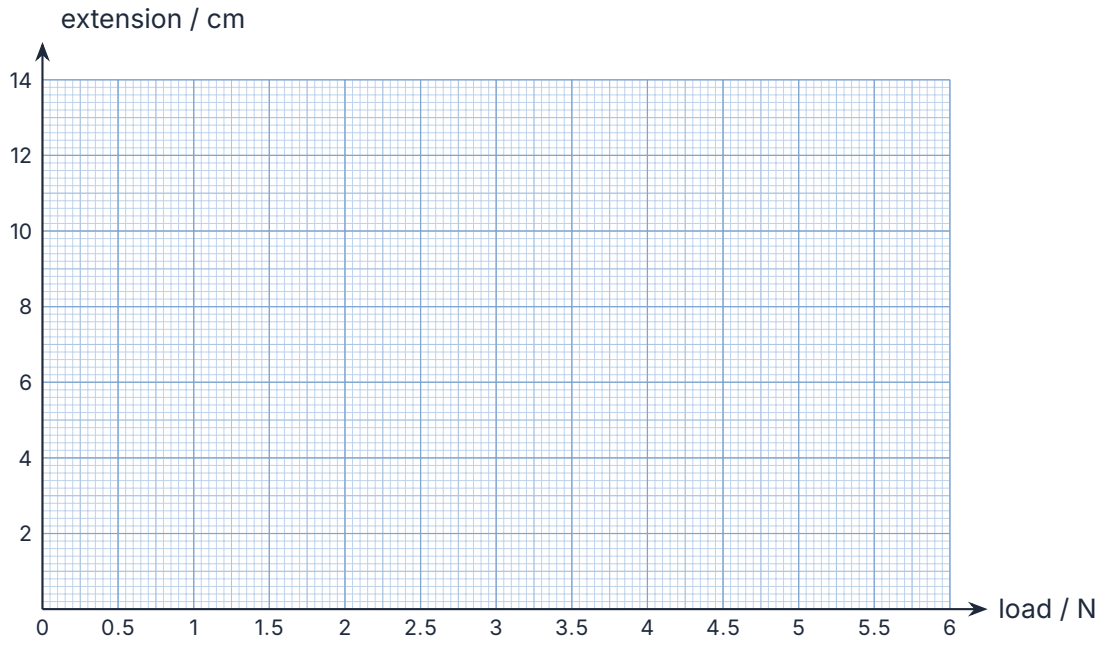
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4 CORE The table shows the results of the student in Question 2. The unstretched length of the spring is 4.0 cm.

load / N	0	1.0	2.0	3.0	4.0	5.0	6.0
length / cm	4.0	6.0	8.0	10.0	12.0	14.5	17.5
extension / cm	0						

(a) Complete the last row of the table. [2]

(b) On the grid, plot a graph of extension against load. Draw the best-fit line or curve through your points. [3]



(c) Describe the shape of your graph. [2]

.....

.....

5 SUPPLEMENT Use your graph from Question 4.

(a) Mark on your graph the **limit of proportionality**. Label it L. [1]

(b) State what is meant by the limit of proportionality. [1]

.....

(c) Calculate the spring constant of the spring in N/m. [3]

.....

.....

spring constant = _____

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6 SUPPLEMENT Define the **spring constant** of a spring. [1]

.....

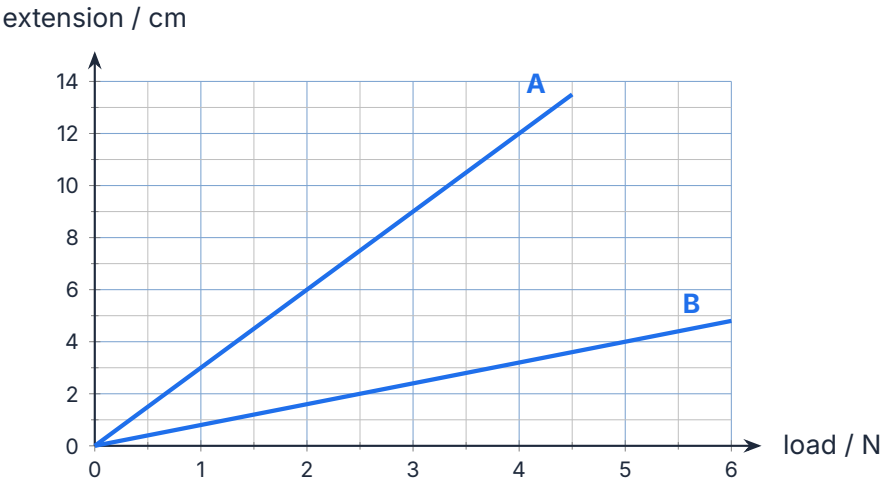
7 SUPPLEMENT A spring has a spring constant of 40 N/m. A load of 2.0 N is hung from it. Calculate the extension of the spring in cm. The limit of proportionality is not reached. [3]

.....

.....

extension = _____

8 SUPPLEMENT The graph shows how the extension of two springs, A and B, changes with load.



(a) State which spring is stiffer. Explain how the graph shows this. [2]

.....

.....

(b) Use the graph to calculate the spring constant of spring B in N/m. [3]

.....

.....

spring constant = _____

Exam tip Extension = stretched length − unstretched length. In $k = F/x$, put the extension in **metres** to get k in N/m.

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Answers: Worksheet 1

Mark codes: B1 independent mark C1 method mark, implied by a correct final answer A1 correct answer with unit. Accept answers that round correctly; allow error carried forward from earlier parts.

Worksheet 1 – Springs and stretching

1 It can change the size or the shape of the object (stretch, squash, bend or twist it). B1

2 **(a)** Read the position of the pointer on the metre rule with no load, then with each load B1; extension = loaded reading − unloaded reading. B1
(b) Any two: read the scale at eye level (avoid parallax); read the scale perpendicular to the rule, e.g. using a set square to line up the pointer; keep the metre rule vertical; let the spring stop moving before reading; add the masses gently. B1 B1

3 8.2 cm is the stretched length, not the extension B1; extension = 8.2 − 5.0 = **3.2 cm** B1

4 **(a)** 0, 2.0, 4.0, 6.0, 8.0, 10.5, 13.5 B2 (B1 for 4 or 5 correct)
(b) All points plotted to within half a small square B2 (B1 for 5 or 6); straight line through the origin up to 4.0 N, then a smooth curve B1
(c) A straight line through the origin (extension proportional to load) up to about 4 N B1; above this it curves upwards: the extension increases more for each newton. B1

5 **(a)** L marked on the line at a load from 4.0 N to 4.5 N, where the line starts to curve B1
(b) The point beyond which the extension is no longer proportional to the load. B1
(c) $k = F/x = 4.0 \div 0.080$ C1 (extension in m C1) = **50 N/m** A1

6 Force per unit extension. B1

7 $x = F/k = 2.0 \div 40$ C1 = 0.050 m C1 = **5.0 cm** A1

8 **(a)** **B** B1; for the same load it stretches less (smaller gradient on the graph). B1
(b) Reading from the line, e.g. 5.0 N gives 4.0 cm C1
$k = 5.0 \div 0.040$ C1 = **125 N/m** (accept 130) A1

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Get the full pack

You have just used Worksheet 1. The full Forces pack contains:

- **Worksheet 1:** Springs and stretching
- **Worksheet 2:** Resultant force and motion
- **Worksheet 3:** Moments
- **Worksheet 4:** Centre of gravity and stability
- **Multiple-choice practice:** 10 Paper 1/2-style questions
- **Practical skills:** an Alternative to Practical (Paper 6) question
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