AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.3

Forces and elasticity

Past-paper questions

Tier	**Higher**
Question groups	**15**
Available paper years	**2008–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

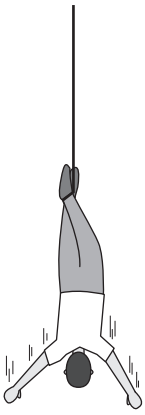
4.5.3 Forces and elasticity

Question 01

June 2008 | PHY1AP | Original Q2 | Legacy

QUESTION TWO

During a bungee jump, energy is transformed.



Match energy types, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A gravitational potential energy

B heat (thermal energy)

C kinetic energy

D elastic potential energy

At the top of the jump there is . . . **1** . . . .

As the bungee jumper falls, he gains . . . **2** . . . .

During the fall, energy is wasted as . . . **3** . . . .

As the bungee cord is stretched, it gains . . . **4** . . . .

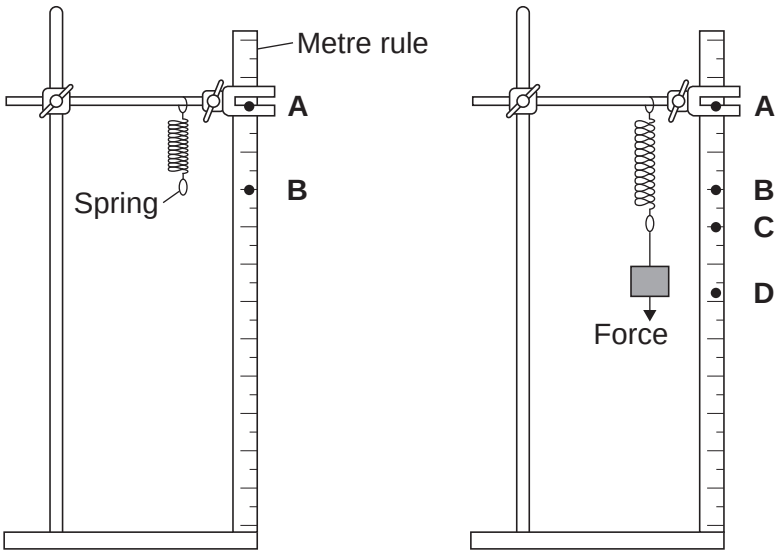
4.5.3 Forces and elasticity

Question 02

June 2012 | PH2HP | Original Q1 | Legacy

1 A student investigated how the extension of a spring depends on the force applied to the spring.

The diagram shows the spring before and after a force had been applied.



1 (a) (i) Complete the following sentence using letters, **A**, **B**, **C** or **D**, from the diagram.

The extension of the spring is the distance between the positions labelled .....

and ..... on the metre rule.

(1 mark)

1 (a) (ii) What form of energy is stored in the stretched spring?

.....

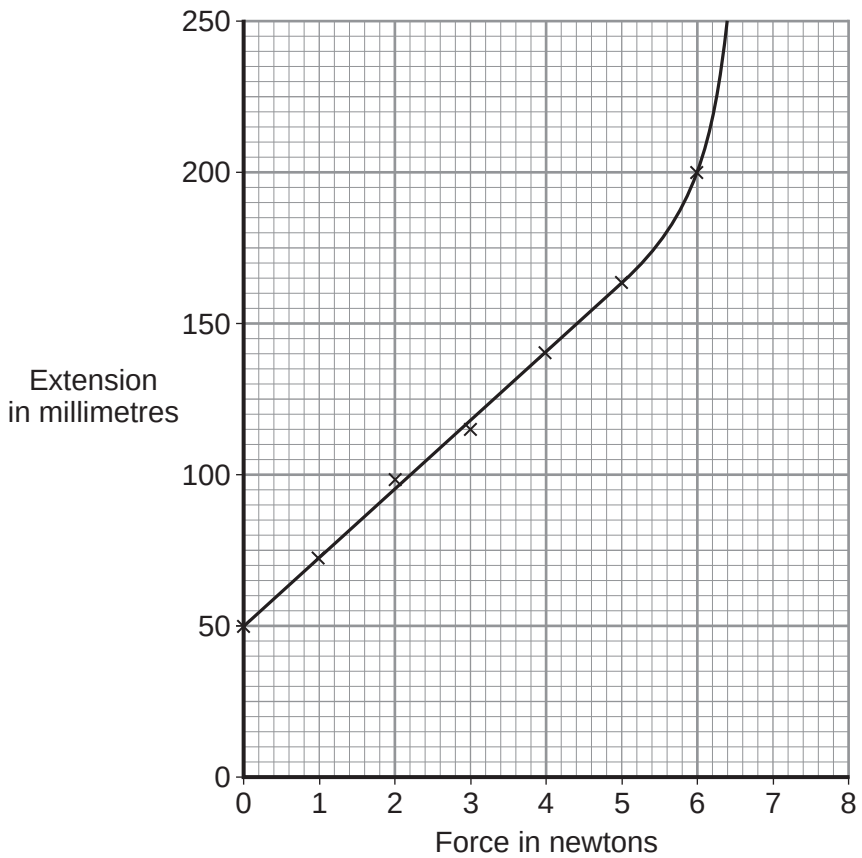
(1 mark)

Question 1 continues on the next page

4.5.3 Forces and elasticity

Question 02 · continued

1 (b) The results from the investigation are plotted on the following graph.



1 (b) (i) The graph shows that the student has made an error throughout the investigation.

What error has the student made?

.....

.....

Give the reason for your answer.

.....

.....

(2 marks)

4.5.3 Forces and elasticity

Question 02 · continued

1 (b) (ii) The student has loaded the spring beyond its *limit of proportionality*.

Mark on the graph line the *limit of proportionality* of the spring. Label the point **P**.

Give the reason for choosing your point **P**.

.....

.....

.....

(2 marks)

1 (c) The student uses a different spring as a spring balance. When the student hangs a stone from this spring, its extension is 72 mm.

The spring does not go past the limit of proportionality.

Calculate the force exerted by the stone on the spring.

spring constant = 25 N/m

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

.....

Force = ... N

(2 marks)

8

4.5.3 Forces and elasticity

Question 03

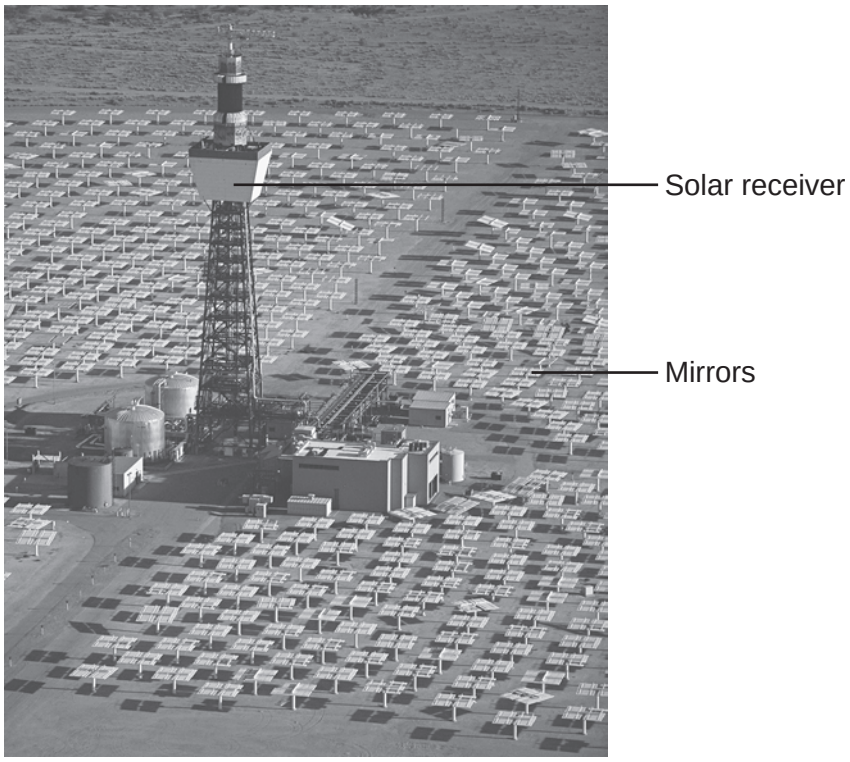
June 2015 | PH1HP | Original Q5 | Legacy

5 **Figure 5** shows a solar thermal power station that has been built in a hot desert.

The power station uses energy from the Sun to heat water to generate electricity.

Energy from the Sun is reflected towards a solar receiver using many mirrors.

Figure 5



5 (a) (i) Which part of the electromagnetic spectrum provides most of the energy to heat the water in a solar thermal power station?

[1 mark]

.....

Question 03 · continued

5 (a) (ii) Describe how heated water is used to generate electricity by this solar thermal power station.
The process is the same as in a fossil fuel power station.

[3 marks]

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5 (b) A new type of solar power station, called a solar storage power station, is able to store energy from the Sun by heating molten chemical salts.
The stored energy can be used to generate electricity at night.

5 (b) (i) It is important that the molten chemical salts have a high specific heat capacity.
Suggest **one** reason why.

[1 mark]

.....

.....

5 (b) (ii) The solar storage power station can store a maximum of 2 200 000 kWh of energy.
The solar storage power station can supply a town with a maximum electrical power of 140 000 kW.

Calculate for how many hours the energy stored by the solar storage power station can supply the town with electrical power.

Give your answer to 2 significant figures.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

Time = ... hours

Question 5 continues on the next page

5 (b) (iii) **Table 3** gives information about the place where the solar storage power station has been built.

Table 3

Season	Mean number of daylight hours	Mean power received from the Sun per square metre in kW
Spring	11.5	0.90
Summer	13.5	1.10
Autumn	12.0	0.95
Winter	10.5	0.71

The solar storage power station does not operate at the maximum possible electrical output every day of the year.

Suggest why.

[2 marks]

.....

.....

.....

.....

5 (c) Power stations do not work at maximum possible electrical output all the time.
The 'capacity factor' of a power station is calculated using the equation:

$$\text{Capacity factor} = \frac{\text{actual electrical output per year}}{\text{maximum possible electrical output per year}}$$

Question 03 · continued

Table 4 shows capacity factors for different types of power station.

Table 4

Type of power station	Renewable energy source	Capacity factor
Coal	No	0.41
Natural gas	No	0.48
Nuclear	No	0.66
Solar thermal	Yes	0.33
Tidal	Yes	0.26
Wind turbine	Yes	0.30

5 (c) (i) Compare the capacity factors of the renewable power stations with those of the non-renewable power stations in **Table 4**.
Explain the reason for the difference between the capacity factors.

[3 marks]

……

……

……

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……

5 (c) (ii) The capacity factor of a solar storage power station is higher than for all other renewable power stations.
Suggest **one** reason why.

[1 mark]

……

……

14

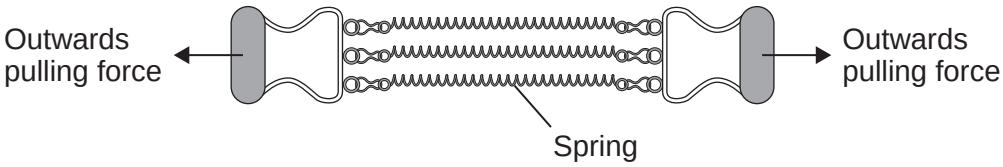
4.5.3 Forces and elasticity

Question 04

June 2016 | PH2HP | Original Q5 | Legacy

5 **Figure 11** shows an exercise device called a chest expander. The three springs are identical.

Figure 11



A person pulls outwards on the handles and does work to stretch the springs.

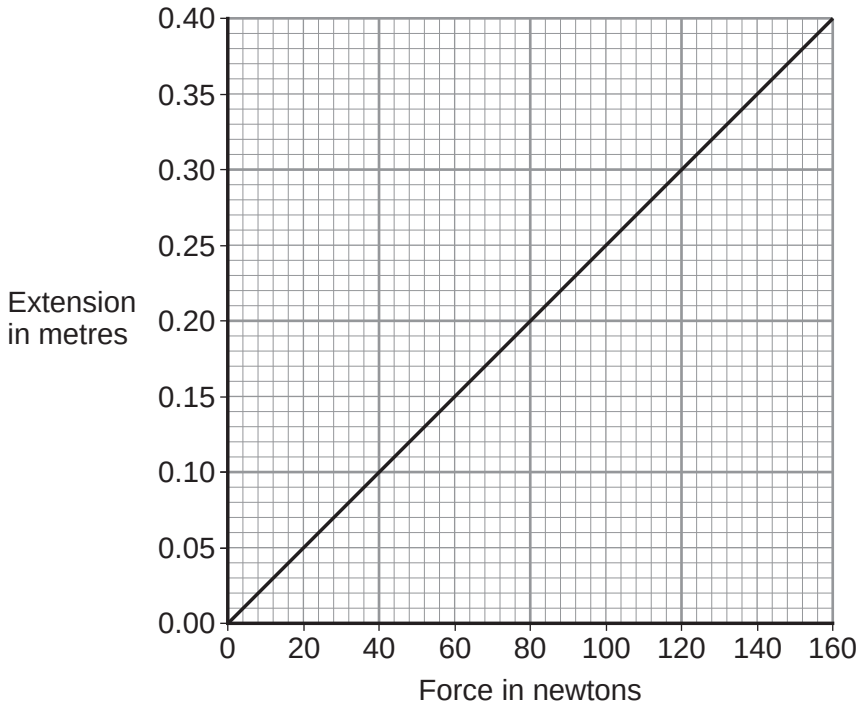
5 (a) Complete the following sentence.

[1 mark]

When the springs are stretched _____ _____ energy is stored in the springs.

5 (b) **Figure 12** shows how the extension of a single spring from the chest expander depends on the force acting on the spring.

Figure 12



Question 04 · continued

5 (b) (i) How can you tell, from **Figure 12**, that the limit of proportionality of the spring has not been exceeded?

[1 mark]

_____

_____

5 (b) (ii) Use data from **Figure 12** to calculate the spring constant of the spring.
Give the unit.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

_____

_____

_____

Spring constant = _____ Unit _____

5 (b) (iii) Three identical resistors joined in parallel in an electrical circuit share the total current in the circuit.

In a similar way, the three springs in the chest expander share the total force exerted.

By considering this similarity, use **Figure 12** to determine the total force exerted on the chest expander when each spring is stretched by 0.25 m.

[2 marks]

_____

_____

Total force = _____ N

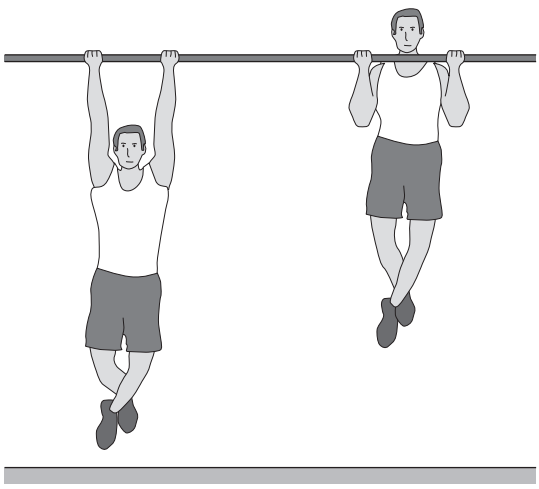
Question 5 continues on the next page

4.5.3 Forces and elasticity

Question 04 · continued

5 (c) The student in **Figure 13** is doing an exercise called a chin-up.

Figure 13



Each time the student does one chin-up he lifts his body 0.40 m vertically upwards.
The mass of the student is 65 kg.
The student is able to do 12 chin-ups in 60 seconds.

Calculate the power developed by the student.

Gravitational field strength = 10 N/kg

Use the correct equations from the Physics Equations Sheet.

[3 marks]

Power = _____ W

10

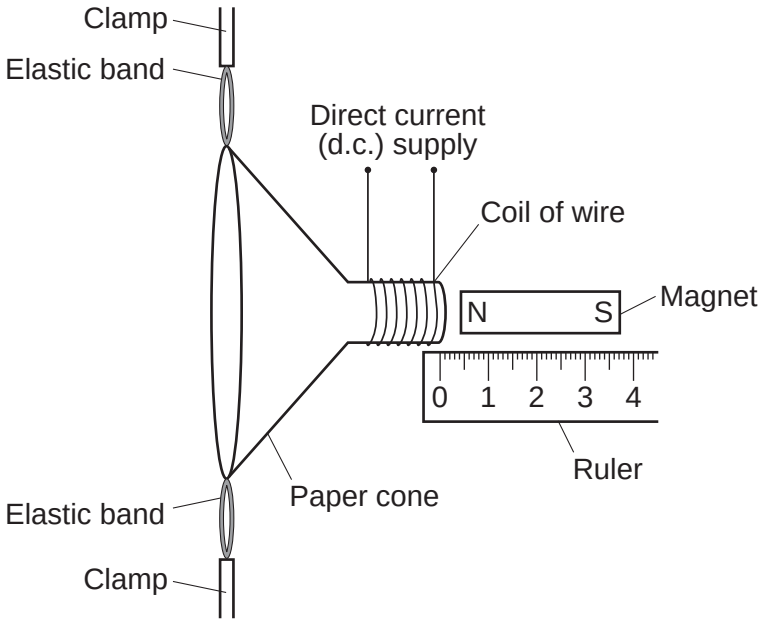
4.5.3 Forces and elasticity

Question 05

June 2017 | PH3HP | Original Q1 | Legacy

1 **Figure 1** shows a loudspeaker made by a student. When there is a current in the coil the paper cone moves.

Figure 1



The student investigates how changing the size of the current in the coil of wire affects the distance moved by the paper cone.

1 (a) State **two** variables the student should control.

[2 marks]

1 _____

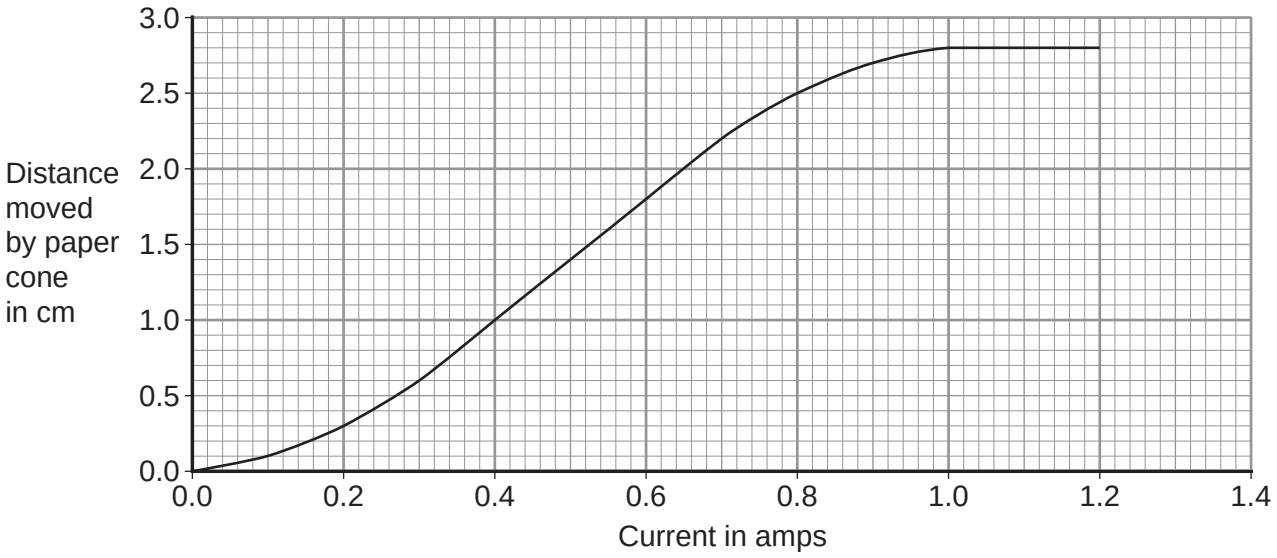
_____

2 _____

_____

1 (b) The results of the student's investigation are shown in **Figure 2**.

Figure 2



1 (b) (i) When the current increases from 0.5 A to 0.9 A, how much does the distance moved increase?

[2 marks]

Increase in distance moved = _____ cm

1 (b) (ii) State **two** conclusions that can be made from the graph.

[2 marks]

1 _____

_____

2 _____

_____

6

4.5.3 Forces and elasticity

Question 06

June 2018 | 8463/2H | Original Q2

0 2 A student carried out an investigation to determine the spring constant of a spring.

Table 1 gives the data obtained by the student.

Table 1

Force in N	Extension in cm
0	0.0
2	3.5
4	8.0
6	12.5
8	16.0
10	20.0

0 2 . 1 Describe a method the student could have used to obtain the data given in **Table 1**.

Your answer should include any cause of inaccuracy in the data.

Your answer may include a labelled diagram.

[6 marks]

4.5.3 Forces and elasticity

Question 06 · continued

0 2 . 2 The student measured the extension for five different forces rather than just measuring the extension for one force.

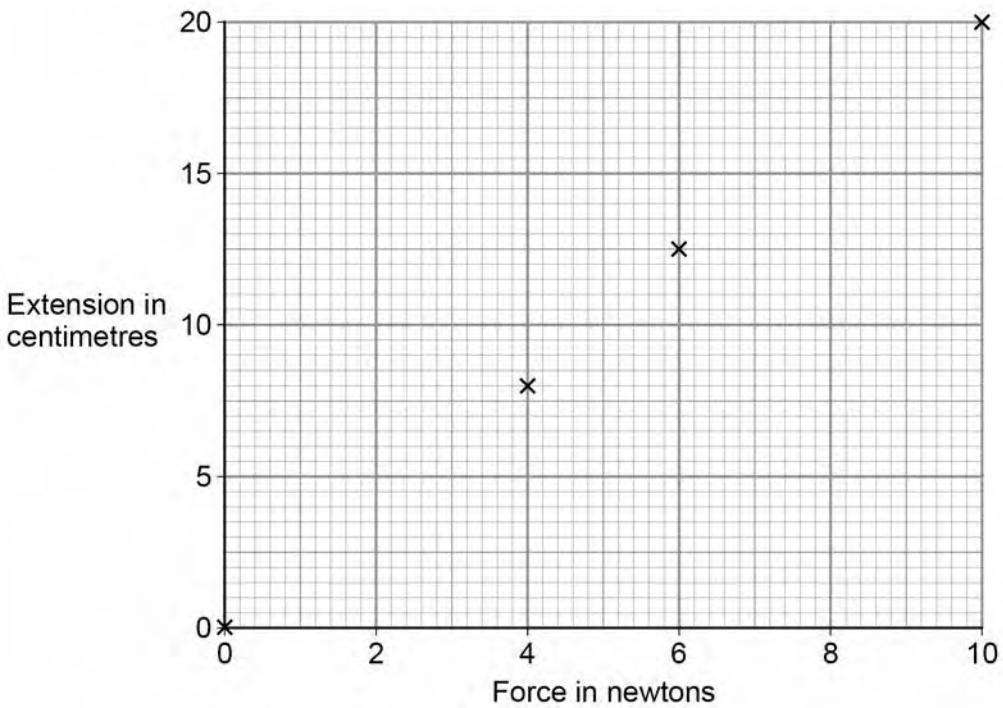
Suggest why.

[1 mark]

Question 2 continues on the next page

Figure 2 shows some of the data obtained by the student.

Figure 2



0 2 . 3 Complete **Figure 2** by plotting the missing data from **Table 1.**

Draw the line of best fit.

Table 1 is repeated here to help you answer this question.

[2 marks]

Table 1

Force in N	Extension in cm
0	0.0
2	3.5
4	8.0
6	12.5
8	16.0
10	20.0

0 2 . 4 Write down the equation that links extension, force and spring constant.

[1 mark]

4.5.3 Forces and elasticity

Question 06 · continued

0 2 . 5 Calculate the spring constant of the spring that the student used.

Give your answer in newtons per metre.

[4 marks]

Spring constant = _____ N/m

0 2 . 6 Hooke's Law states that:
'The extension of an elastic object is directly proportional to the force applied, provided the limit of proportionality is not exceeded.'

The student concluded that over the range of force used, the spring obeyed Hooke's Law.

Explain how the data supports the student's conclusion.

[2 marks]

16

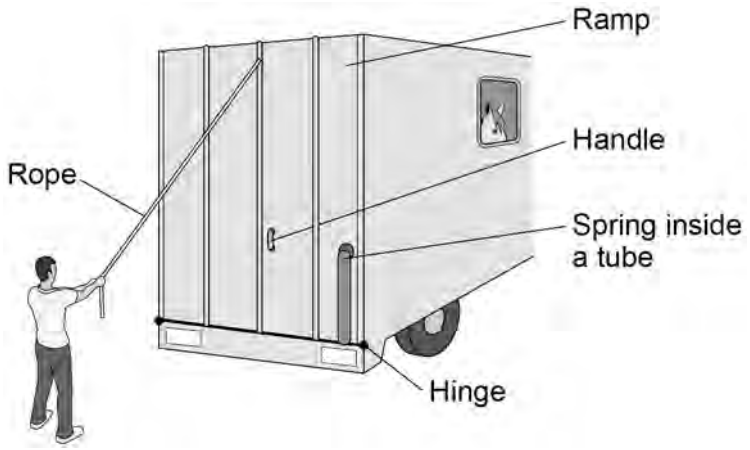
4.5.3 Forces and elasticity

Question 07

June 2019 | 8463/2H | Original Q10

1 0 **Figure 19** shows the back of a lorry. The lorry is used to carry horses.

Figure 19



The ramp is lowered by pulling on the rope or by pulling on the handle.

The hinge acts as a pivot.

1 0 . 1 Explain why it is easier to lower the ramp by pulling on the rope rather than pulling on the handle.

[2 marks]

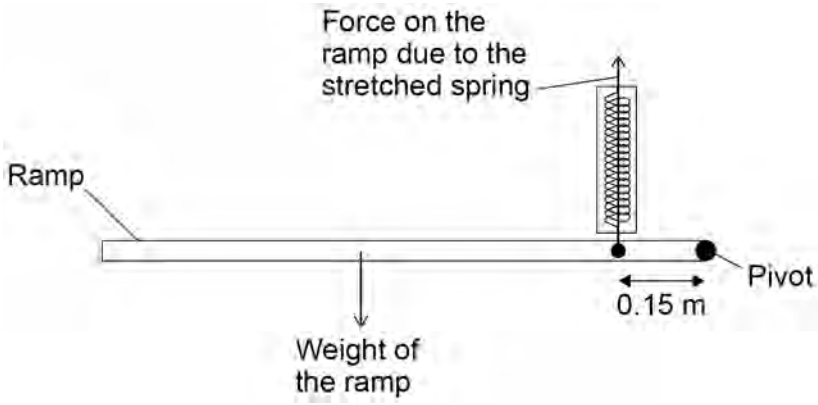
Question 10 continues on the next page

Question 07 · continued

When the ramp is lowered, work is done to stretch a spring on the side of the ramp. Elastic potential energy is stored in the stretched spring.

Figure 20 shows the ramp part way down in a balanced horizontal position.

Figure 20



1 0 . 2 With the ramp horizontal:

the moment caused by the weight of the ramp = 924 Nm

the spring is stretched by 0.250 m

Calculate the elastic potential energy stored in the stretched spring.

Use data from **Figure 20**.

[6 marks]

Elastic potential energy = _____ J

8

4.5.3 Forces and elasticity

Question 08

November 2020 | 8463/2H | Original Q4

0 4 A door is fitted with a security lens and a lock.

The security lens allows a person to see a visitor before opening the door.

The security lens is concave.

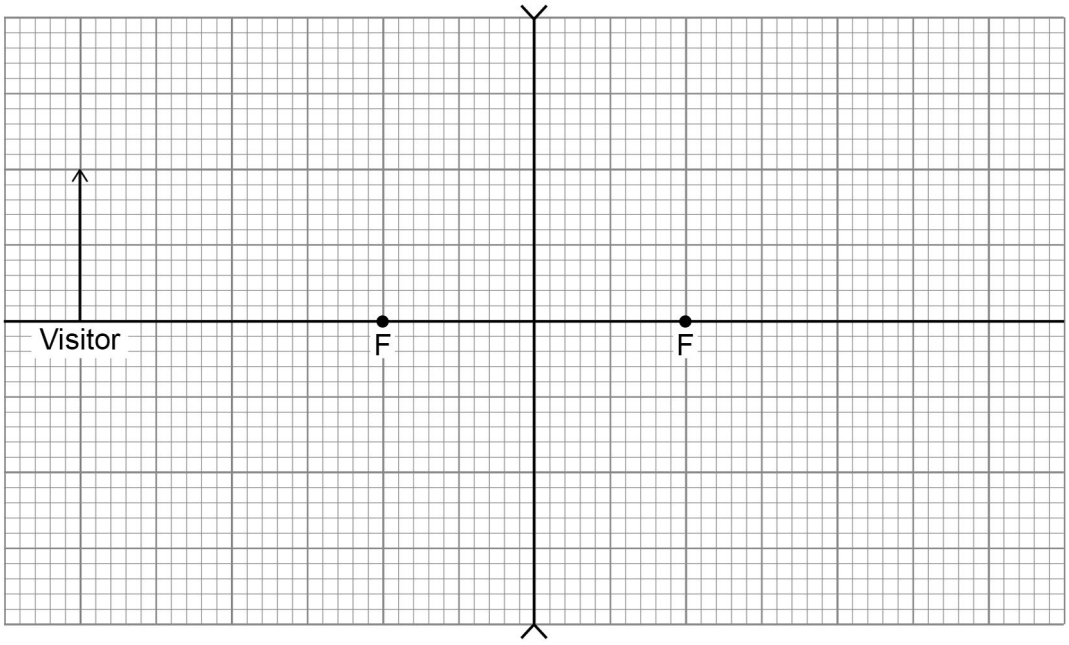
0 4 . 1 **Figure 5** is an incomplete ray diagram representing a visitor standing near the security lens.

Complete **Figure 5** to show how an image of the visitor is formed by the concave lens.

Draw an arrow to represent the image.

[3 marks]

Figure 5



0 4 . 2 The visitor moves further away from the security lens in the door.

How does the size of the image change?

[1 mark]

Tick (✓) **one** box.

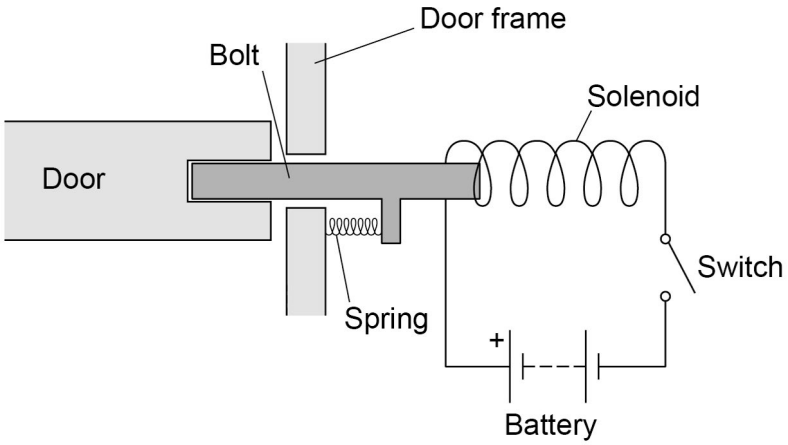
Decreases ☐

Increases ☐

Stays the same ☐

Figure 6 shows a diagram of the lock. The door unlocks when the switch is closed.

Figure 6



0 4 . 3 Which material should the bolt be made from?

[1 mark]

Tick (✓) **one** box.

Aluminium ☐

Brass ☐

Copper ☐

Iron ☐

0 4 . 4 Explain why the door unlocks when the switch is closed.

[3 marks]

4.5.3 Forces and elasticity

Question 08 · continued

0 4 . 5 When the door unlocks, a force of 2.88 N is applied to the spring.

The spring extends by 1.50 cm.

Calculate the spring constant of the spring.

[4 marks]

Spring constant = _____ N/m

0 4 . 6 Give **two** ways the resultant force on the bolt could be increased.

[2 marks]

1 _____

2 _____

14

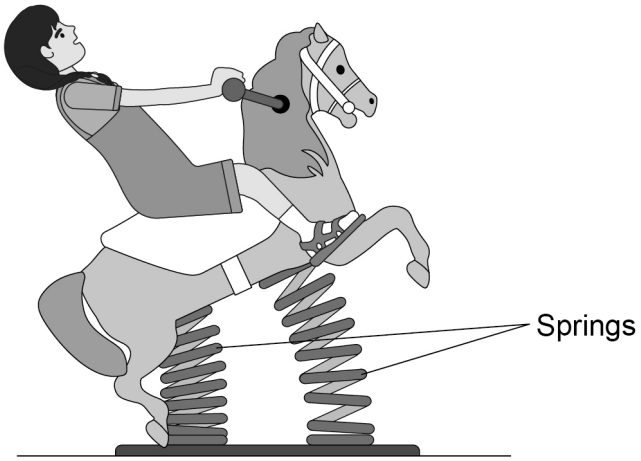
4.5.3 Forces and elasticity

Question 09

November 2021 | 8463/2H | Original Q2

0 2 **Figure 3** shows a child on a playground toy.

Figure 3



0 2 . 1 The springs have been elastically deformed.

Explain what is meant by 'elastically deformed'.

[2 marks]

Question 2 continues on the next page

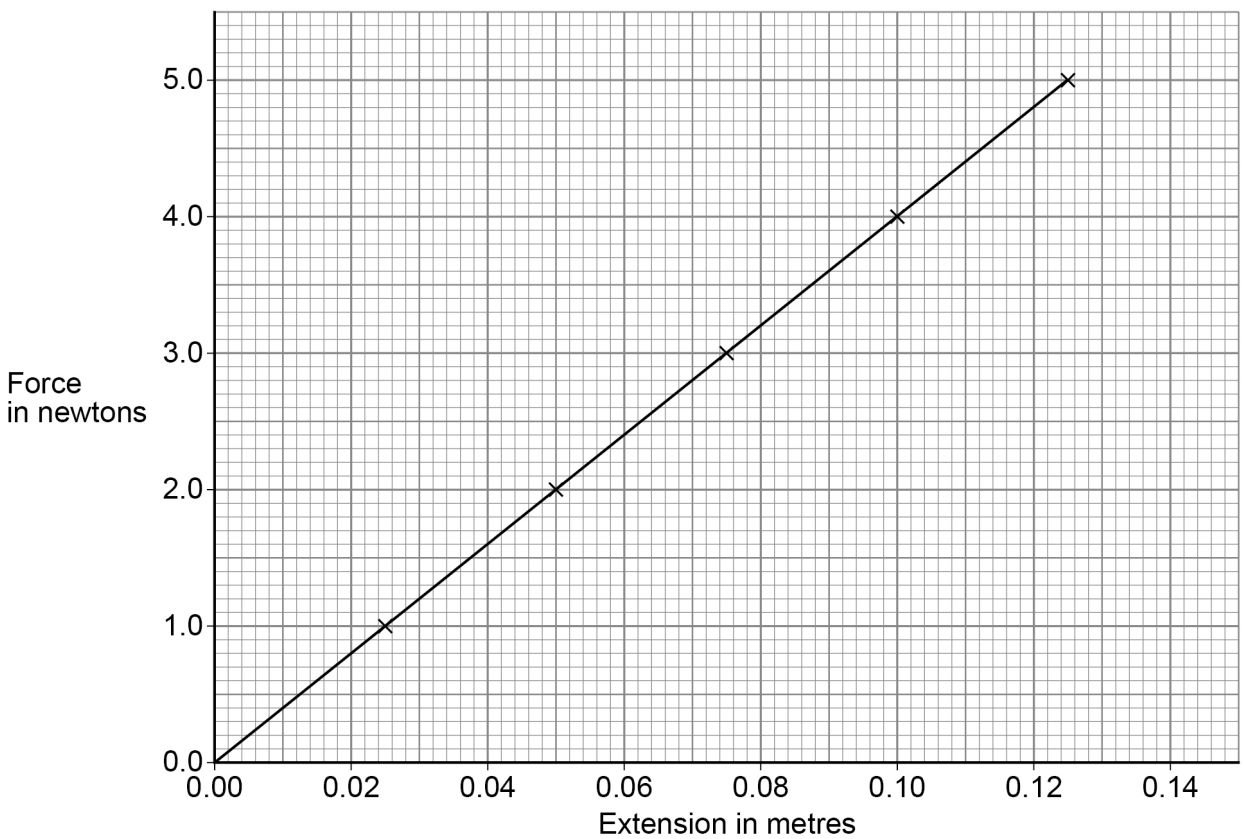
4.5.3 Forces and elasticity

Question 09 · continued

A student investigated the relationship between the force applied to a spring and the extension of the spring.

Figure 4 shows the results.

Figure 4



4.5.3 Forces and elasticity

Question 09 · continued

0 2 . 2 Describe a method the student could use to obtain the results given in **Figure 4**.

You should include a risk assessment for **one** hazard in the investigation.

Your answer may include a diagram.

[6 marks]

Question 2 continues on the next page

Question 09 · continued

0 2 . 3 Which equation links extension (e), force (F) and spring constant (k).

[1 mark]

Tick (✓) **one** box.

force = spring constant × (extension)^2 ☐

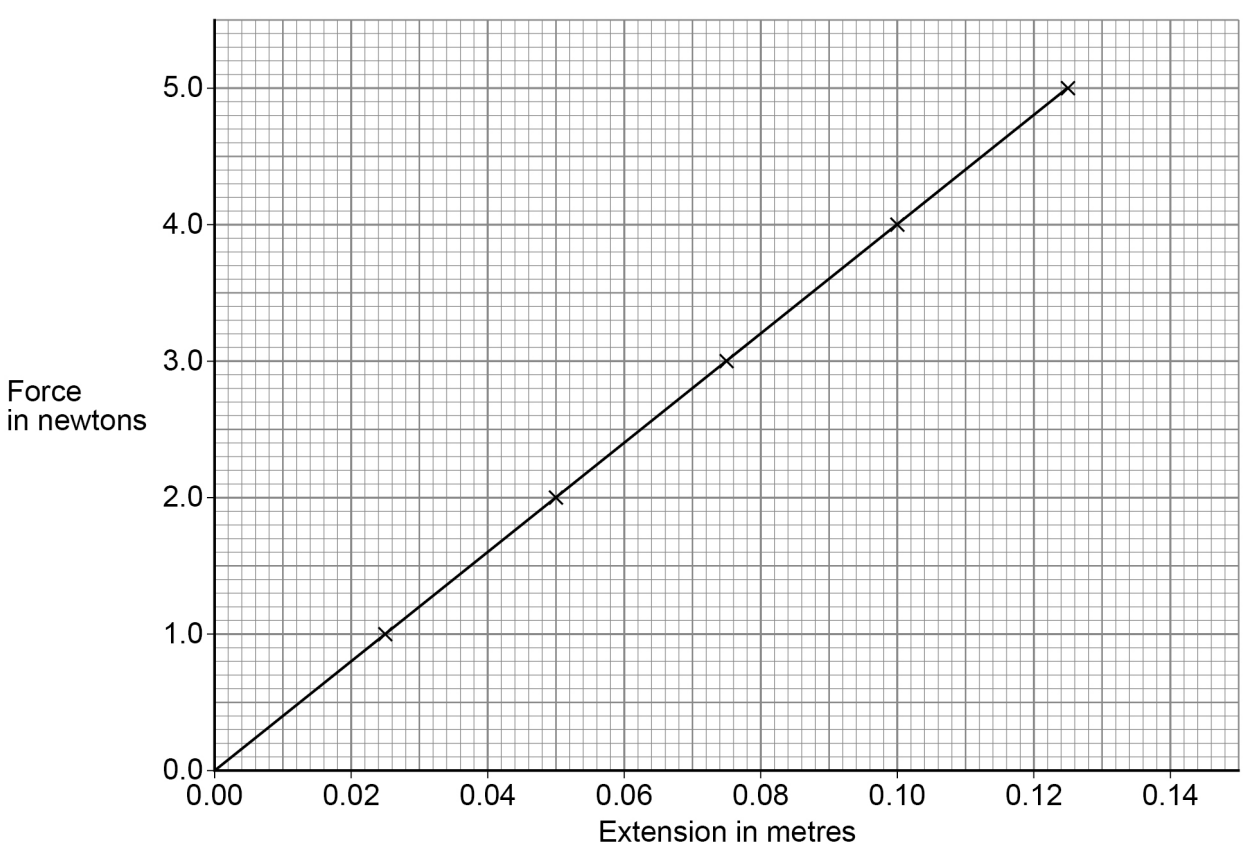
force = spring constant × extension ☐

force = $\frac{\text{extension}}{\text{spring constant}}$ ☐

force = $\frac{\text{spring constant}}{\text{extension}}$ ☐

Figure 4 is repeated below.

Figure 4



0 2 . 4 Determine the spring constant of the spring.

Use **Figure 4**.

[3 marks]

Spring constant = _____ N/m

0 2 . 5 The student concluded:

'The extension of the spring is directly proportional to the force applied to the spring.'

Describe how **Figure 4** supports the student's conclusion.

[2 marks]

Question 2 continues on the next page

4.5.3 Forces and elasticity

Question 09 · continued

0 2 . 6 The student repeated the investigation using a different spring with a spring constant of 13 N/m.

Calculate the elastic potential energy of the spring when the extension of the spring was 20 cm.

Use the Physics Equations Sheet.

[3 marks]

Elastic potential energy = _____ J

17

4.5.3 Forces and elasticity

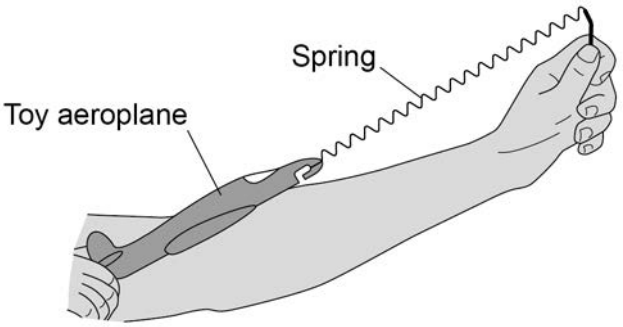
Question 10

June 2022 | 8463/1H | Original Q10

1 0 **Figure 11** shows a student launching a toy aeroplane.

To launch the aeroplane, the student pulls on it to stretch the spring and then releases it.

Figure 11



1 0 . 1 Just before the toy aeroplane is released, the spring has an extension of 0.12 m.

mass of aeroplane = 0.020 kg

spring constant of the spring = 50 N/m

Calculate the maximum speed of the toy aeroplane just after it is launched.

Use the Physics Equations Sheet.

Give the unit.

[6 marks]

Speed = _____ Unit _____

Question 10 · continued

1 0 . 2 Complete the sentence.

[1 mark]

As the aeroplane moves upwards through the air there is a decrease

in the _____ energy of the aeroplane.

1 0 . 3 Give **one** factor which would increase the distance the toy aeroplane travels horizontally before hitting the ground.

[1 mark]

_____

_____

8

Turn over for the next question

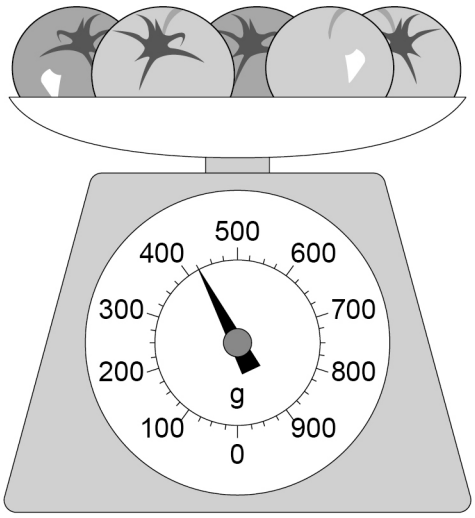
4.5.3 Forces and elasticity

Question 11

June 2022 | 8463/2HR | Original Q5

0 5 **Figure 9** shows a balance used to measure the mass of five tomatoes.

Figure 9



0 5 . 1 What is meant by 'centre of mass'?

[1 mark]

0 5 . 2 Calculate the mean weight of a tomato in **Figure 9**.

Use the Physics Equations Sheet.

gravitational field strength = 9.8 N/kg

[3 marks]

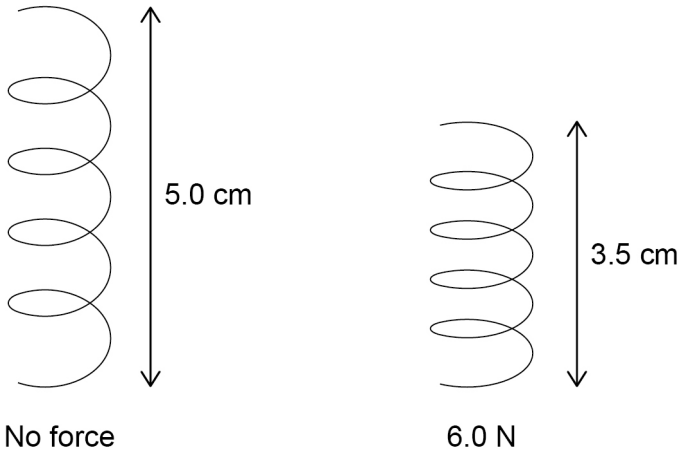
Weight = _____ N

Question 11 · continued

0 5 . 3 The balance in **Figure 9** contains a spring that compresses when the tomatoes are placed on the balance.

Figure 10 shows the spring with no force acting and with a 6.0 N force acting.

Figure 10



Determine the spring constant of the spring.

Use the Physics Equations Sheet.

[3 marks]

Spring constant = _____ N/m

0 5 . 4 Explain **one** property of the spring that makes it suitable for use in the balance.

[2 marks]

9

4.5.3 Forces and elasticity

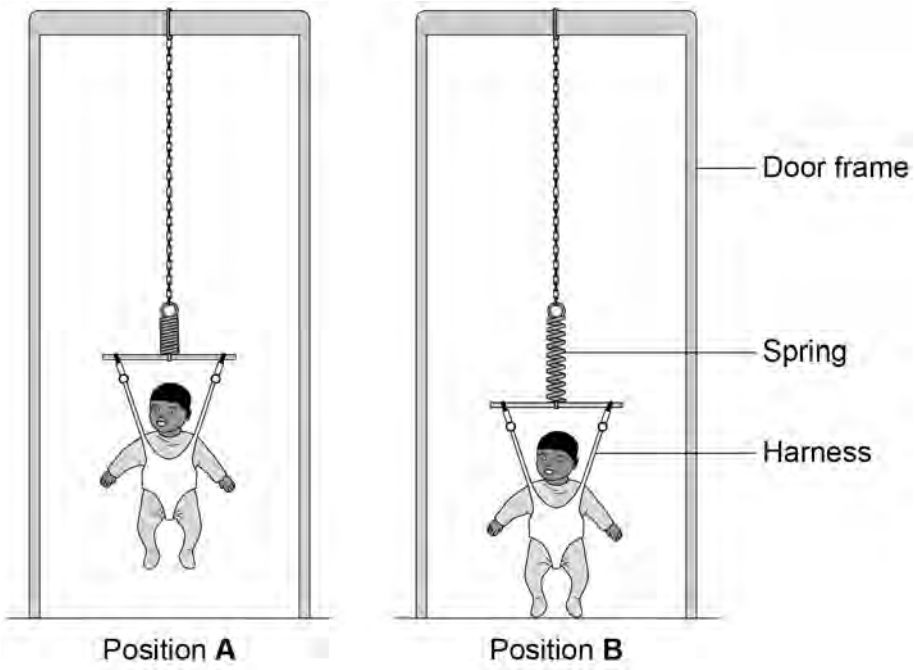
Question 12

June 2023 | 8463/1H | Original Q7

0 7 A baby bouncer is a harness attached to a spring that hangs from a door frame.

Figure 7 shows a baby in a baby bouncer in two positions.

Figure 7



0 7 . 1 The baby bouncer should not be used with babies that have a mass greater than 12 kg.

Suggest **one** reason why.

[1 mark]

4.5.3 Forces and elasticity

Question 12 · continued

0 7 . 2 In positions **A** and **B** the baby is stationary.

Describe the energy transfers as the baby moves from position **A** to position **B**.

[3 marks]

0 7 . 3 In one position the extension of the spring is 8.0 cm.

The elastic potential energy stored by the spring is 4.0 J.

Calculate the spring constant of the spring.

Use the Physics Equations Sheet.

[4 marks]

Spring constant = _____ N/m

8

4.5.3 Forces and elasticity

Question 13

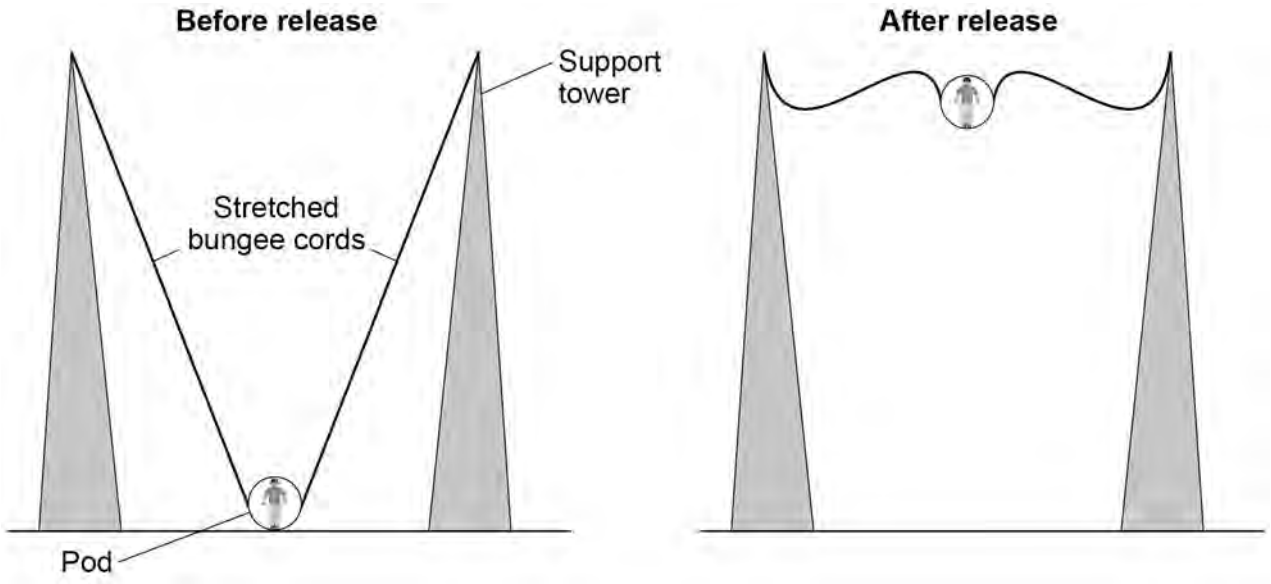
June 2024 | 8463/1H | Original Q6

0 6 In a ride at a theme park, a person is strapped into a pod that is attached to two stretched bungee cords.

The bungee cords behave like springs.

Figure 10 shows a person using the ride.

Figure 10



0 6 . 1 Which energy store increases as the bungee cords are stretched?

[1 mark]

Question 13 · continued

0 6 . 2 When the pod is released, the pod accelerates upwards.

Before the pod is released the extension of **each** of the two bungee cords is 8.0 m.

The spring constant of each bungee cord is 735 N/m.

The mass of the pod is 240 kg.

gravitational field strength = 9.8 N/kg

Calculate the maximum height reached by the pod.

Use the Physics Equations Sheet.

[6 marks]

Maximum height = _____ m

0 6 . 3 The actual maximum height reached by the pod will be lower than the correct answer to Question **06.2**

Explain why.

[2 marks]

9

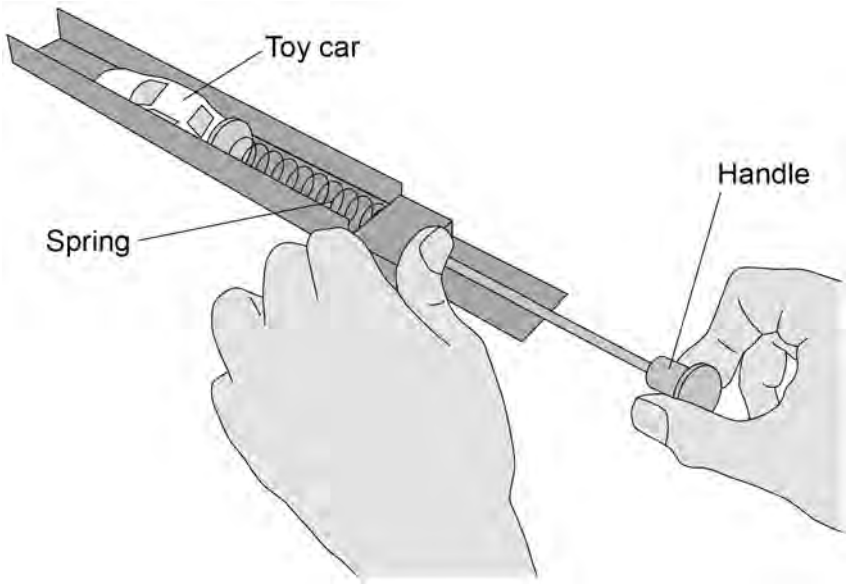
4.5.3 Forces and elasticity

Question 14

June 2025 | 8463/1H | Original Q10

1 0 **Figure 12** shows a device that accelerates a toy car at the start of a race track.

Figure 12



Question 14 · continued

1 0 . 1 Pulling the handle compresses the spring in the device by 0.075 m.

When the handle is released, the energy stored in the compressed spring is transferred to the toy car.

spring constant = 64 N/m

mass of toy car = 0.052 kg

Calculate the maximum possible speed of the toy car just after the car starts to move.

Use the Physics Equations Sheet.

Give your answer to **2** significant figures.

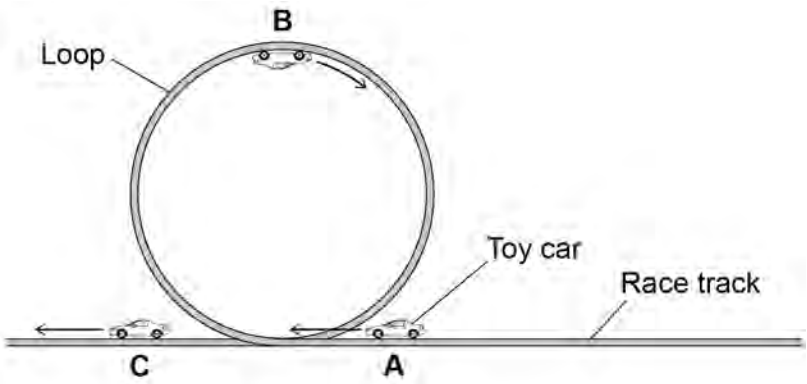
[6 marks]

Maximum possible speed (2 significant figures) = _____ m/s

Question 10 continues on the next page

1 0 . 2 **Figure 13** shows the path of the toy car along a loop section of the race track.

Figure 13



The car moves along the track from position **A** to position **B** and then to position **C**.

Describe how the energy stores of the car change as the car moves along the track from position **A** to position **C**.

Ignore the effects of friction and air resistance.

[3 marks]

Question 14 · continued

10.3 At the end of the race track, the toy car passes through a light gate that measures the speed of the car.

Which **two** measurements are needed to determine the speed of the car?

[2 marks]

Tick (✓) **two** boxes.

- Length of the toy car ☐
- Mass of the toy car ☐
- Temperature of the room ☐
- Time for the toy car to pass the light gate ☐
- Total length of the race track ☐

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4.5.3 Forces and elasticity

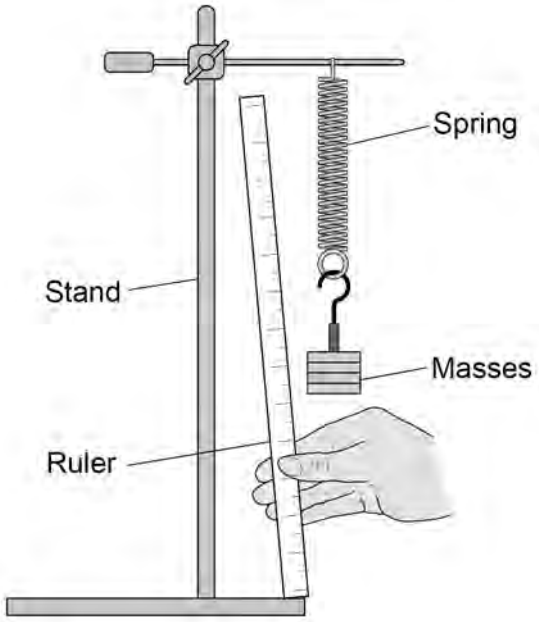
Question 15

June 2025 | 8463/2H | Original Q2

0 2 A student investigated how the force applied to a spring affects the length of the spring.

Figure 1 shows the apparatus used.

Figure 1



0 2 . 1 What is the independent variable in this investigation?

[1 mark]

0 2 . 2 Describe **one** risk of harm in this investigation and a safety precaution to reduce the risk.

[2 marks]

Risk of harm

Safety precaution

0 2 . 3 The student measured the length of the spring using the arrangement shown in **Figure 1**.

Give **two** ways the student could have changed the arrangement to improve the accuracy of the measurement.

[2 marks]

1 _____

_____

2 _____

_____

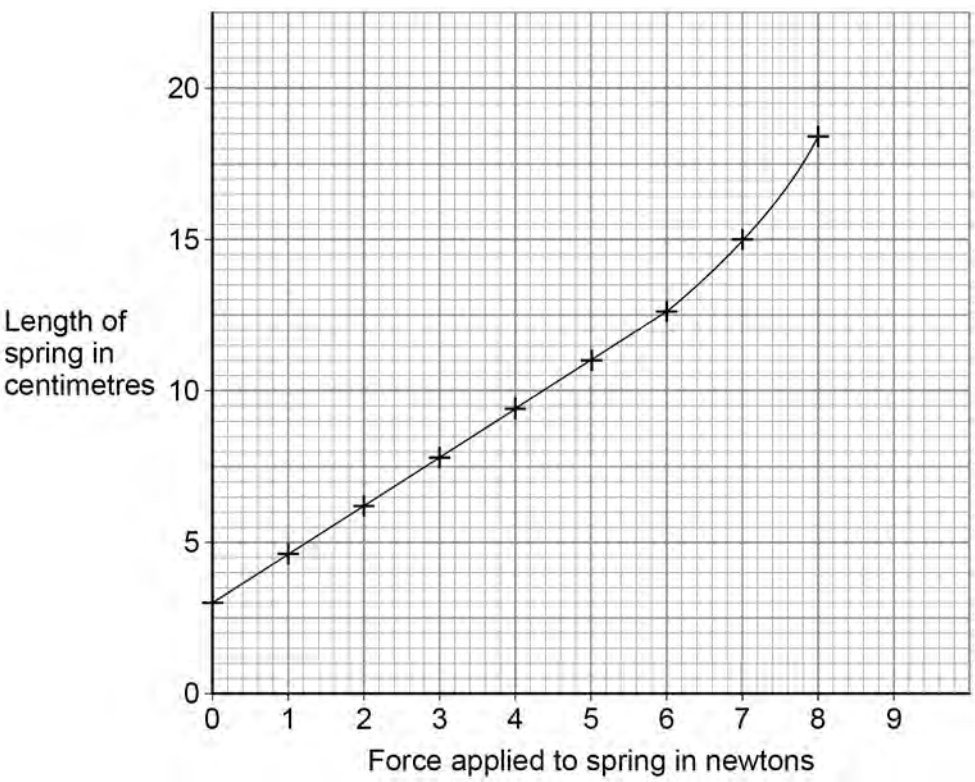
Question 2 continues on the next page

The student recorded accurate values for the length of the spring as the mass on the spring increased.

The student calculated the force applied to the spring by each mass.

Figure 2 shows the results.

Figure 2



0 2 . 4 Why does the line on the graph **not** pass through the origin?

[1 mark]

0 2 . 5 Above 6.0 N the line on **Figure 2** curves upwards.

Explain why.

[2 marks]

Use the Physics Equations Sheet to answer questions **02.6** and **02.7**.

0 2 . 6 Which equation links extension (*e*), force (*F*) and spring constant (*k*)?

[1 mark]

Tick (✓) **one** box.

force = spring constant × extension ☐

force = $\frac{\text{spring constant}}{\text{extension}}$ ☐

force = $\frac{\text{extension}}{\text{spring constant}}$ ☐

0 2 . 7 When the force on the spring is 4.0 N, the extension of the spring is 0.064 m.

Calculate the spring constant of the spring.

[3 marks]

Spring constant = _____ N/m

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