AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.1.1.2

Changes in energy

Past-paper questions

Tier	**Higher**
Question groups	**12**
Available paper years	**2018–2024**

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.

6.1.1.2 Changes in energy

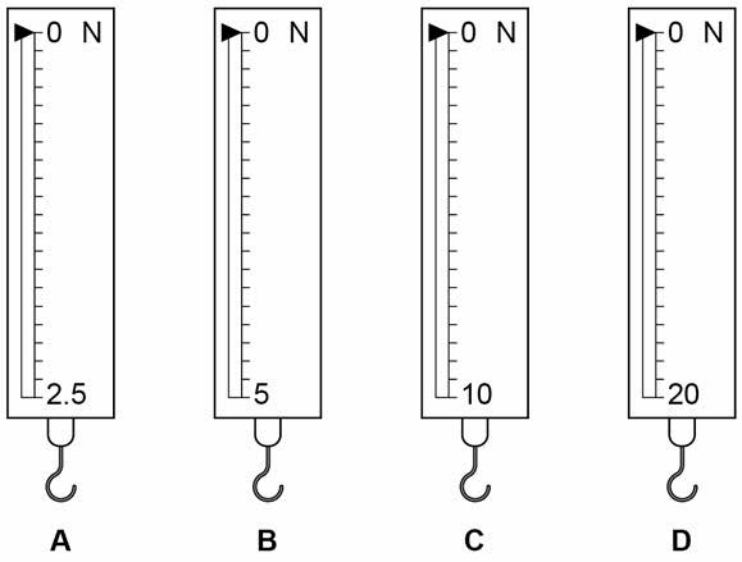
Question 01

June 2018 | 8464/P/2H | Original Q4

0 4 . 1 **Figure 6** shows four newtonmeters.

Each newtonmeter contains a spring.

Figure 6



Which newtonmeter has the spring with the greatest spring constant?

Give a reason for your answer.

[2 marks]

Newtonmeter _____

Reason _____

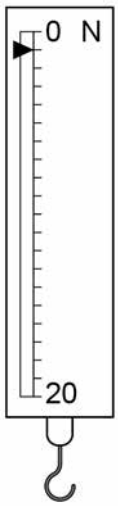
_____

6.1.1.2 Changes in energy

Question 01 · continued

0 4 . 2 The newtonmeter in **Figure 7** will give an error when used to make a measurement.

Figure 7



Name the type of error.

Describe how this error can be corrected.

[2 marks]

Type of error _____

Correction _____

_____

Question 4 continues on the next page

6.1.1.2 Changes in energy

Question 01 · continued

0 4 . 3 A student hangs a weight on a newtonmeter.

The energy now stored in the spring in the newtonmeter is 4.5×10^{-2} J

The student then increases the weight on the newtonmeter by 2.0 N

Calculate the total extension of the spring.

Spring constant = 400 N/m

[6 marks]

Total extension = _____ m

10

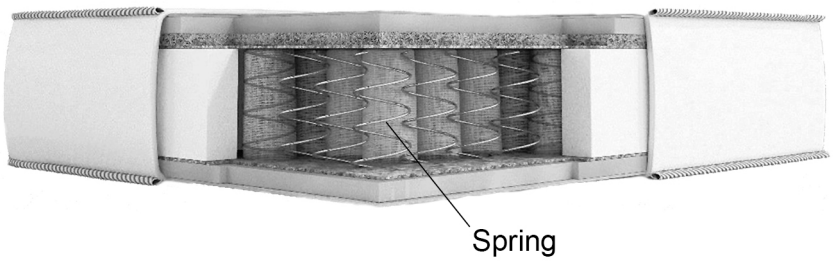
6.1.1.2 Changes in energy

Question 02

June 2019 | 8464/P/2H | Original Q5

0 5 **Figure 8** shows some springs inside a mattress.

Figure 8



0 5 . 1 Which proportionality is true when a force is applied to a spring?

[1 mark]

Tick (✓) **one** box.

- Force ∝ energy stored ☐
- Force ∝ extension ☐
- Force ∝ length ☐
- Force ∝ spring constant ☐

6.1.1.2 Changes in energy

Question 02 · continued

A mattress contains 1200 identical springs.

A person lies on the mattress and the springs compress.

The mean force on each spring in the mattress is 0.49 N

0 5 . 2 Calculate the mass of the person.

gravitational field strength = 9.8 N/kg

[4 marks]

Mass = _____ kg

Question 5 continues on the next page

6.1.1.2 Changes in energy

Question 02 · continued

0 5 . 3 The mean compression of each spring is 3.5×10^{-3} m

Calculate the spring constant of each spring in the mattress.

Give the unit.

[4 marks]

Spring constant = _____

Unit = _____

0 5 . 4 For a given force, different springs compress by different amounts.

Explain what property of the springs would make the mattress soft.

[2 marks]

11

6.1.1.2 Changes in energy

Question 03

November 2020 | 8464/P/1H | Original Q7

0 7 Kangaroos are large animals that travel by jumping.

Figure 8 shows a kangaroo.

Figure 8



Each leg of a kangaroo has a tendon connected to a muscle. Each tendon can be modelled as a spring.

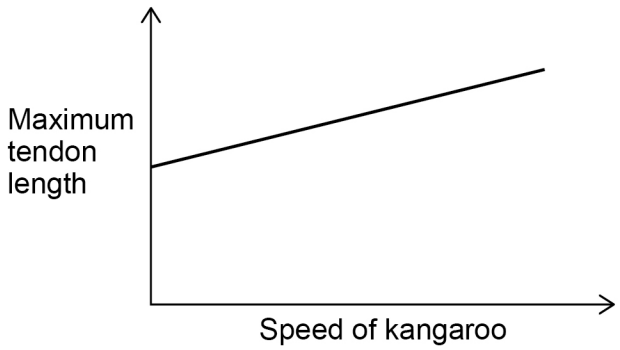
When a jumping kangaroo lands on the ground, the tendons stretch.

6.1.1.2 Changes in energy

Question 03 · continued

0 7 . 1 **Figure 9** shows a sketch graph of how the maximum tendon length during a jump changes with the speed of the kangaroo.

Figure 9



Explain why a kangaroo can jump higher as its speed increases.

[3 marks]

Question 7 continues on the next page

6.1.1.2 Changes in energy

Question 03 · continued

0 7 . 2 A kangaroo has a maximum gravitational potential energy during one jump of 770 J

When the kangaroo lands on the ground 14% of the maximum gravitational potential energy is transferred to elastic potential energy in one tendon.

The tendon has an unstretched length of 35.0 cm

When the kangaroo lands on the ground the tendon stretches to a length of 42.0 cm

Calculate the spring constant of the tendon.

[5 marks]

Spring constant = _____ N/m

8

6.1.1.2 Changes in energy

Question 04

November 2020 | 8464/P/2H | Original Q3

0 3 **Figure 5** shows a computer keyboard.

There is a spring under each key.

Figure 5



0 3 . 1 The springs behave elastically when a force is applied.

What is meant by elastic behaviour?

[1 mark]

Tick (✓) **one** box.

The spring will be compressed when the force is applied to it. ☐

The spring will become deformed when the force is applied to it. ☐

The spring will become longer when the force is removed. ☐

The spring will return to its original length when the force is removed. ☐

Question 04 · continued

0 3 . 2 Suggest **two** properties that should be the same for each spring.

[2 marks]

1 _____

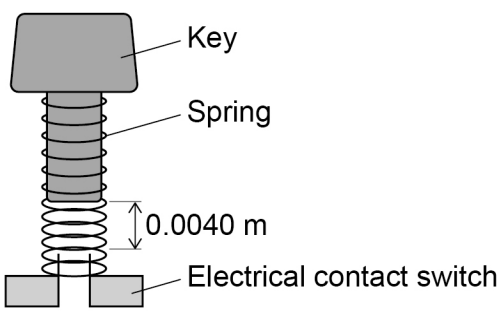
_____

2 _____

_____

0 3 . 3 **Figure 6** shows one of the keys and its spring.

Figure 6



The key must be pressed with a minimum force of 0.80 N before the key touches the switch.

Calculate the spring constant of the spring in **Figure 6**.

[3 marks]

_____

_____

_____

_____

_____

_____

Spring constant = _____ N/m

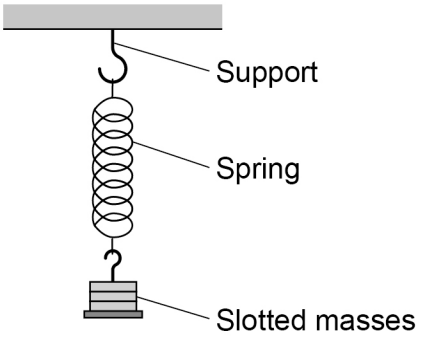
6.1.1.2 Changes in energy

Question 04 · continued

0 3 . 4 **Figure 7** shows a spring that has been hung from a support.

The spring is stationary and has been stretched beyond its limit of proportionality.

Figure 7



Which **two** statements are true for the spring in **Figure 7**?

[2 marks]

Tick (✓) **two** boxes.

The elastic potential energy of the spring is zero. ☐

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

The upward force on the spring is equal to the downward force. ☐

The spring cannot be stretched any further. ☐

The spring is inelastically deformed. ☐

8

6.1.1.2 Changes in energy

Question 05

November 2021 | 8464/P/1H | Original Q3

0 3 **Figure 4** shows a sailing boat crossing an ocean.

Figure 4



There is a wind turbine on the boat.

0 3 . 1 The wind turbine generates electricity to charge a battery on the boat.

Name one **other** renewable energy resource that could be used on the boat to generate electricity.

[1 mark]

_____

0 3 . 2 The boat also has a generator that burns a fossil fuel.

The battery can be charged by either the wind turbine **or** the generator.

Give **two** reasons why this is useful.

[2 marks]

1 _____

_____

2 _____

_____

6.1.1.2 Changes in energy

Question 05 · continued

0 3 . 3 Explain **one** environmental impact of using fossil fuels to generate electricity.

[2 marks]

0 3 . 4 The kinetic energy of the boat is 81 kJ.

mass of boat = 8000 kg

Calculate the speed of the boat.

[4 marks]

Speed = _____ m/s

Question 3 continues on the next page

6.1.1.2 Changes in energy

Question 05 · continued

0 3 . 5 As the boat passes over a wave, the gravitational potential energy of the boat increases by 19 600 J.

mass of boat = 8000 kg

gravitational field strength = 9.8 N/kg

Calculate the change in height of the centre of mass of the boat as it passes over the wave.

[3 marks]

Change in height = _____ m

12

6.1.1.2 Changes in energy

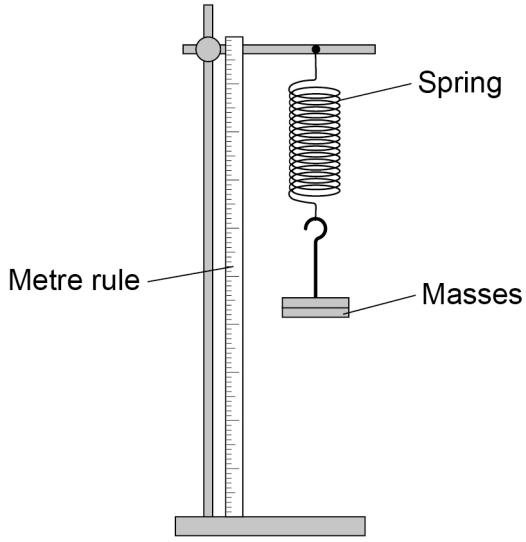
Question 06

November 2021 | 8464/P/2H | Original Q1

0 1 **Figure 1** shows a stretched spring.

The spring is elastically deformed.

Figure 1



0 1 . 1 What is meant by 'elastically deformed'?

[1 mark]

Tick (✓) **one** box.

As the force on the spring increases the length of the spring increases. ☐

Only a very small force is needed to stretch the spring. ☐

The force on the spring causes it to change shape. ☐

The spring will return to its original length when the force is removed. ☐

6.1.1.2 Changes in energy

Question 06 · continued

0 1 . 2 Describe a method to determine the extension of the spring.

[2 marks]

0 1 . 3 The extension of the spring is 80 mm.

spring constant = 40 N/m

Calculate the elastic potential energy of the spring.

Use the Physics Equations Sheet.

[3 marks]

Elastic potential energy = _____ J

Question 1 continues on the next page

6.1.1.2 Changes in energy

Question 06 · continued

0 1 . 4 Write down the equation which links extension (*e*), force (*F*) and spring constant (*k*).

[1 mark]

0 1 . 5 A force of 300 N acts on a different spring.

The force causes the spring to extend by 0.40 m.

Calculate the spring constant of the spring.

[3 marks]

Spring constant = _____ N/m

10

6.1.1.2 Changes in energy

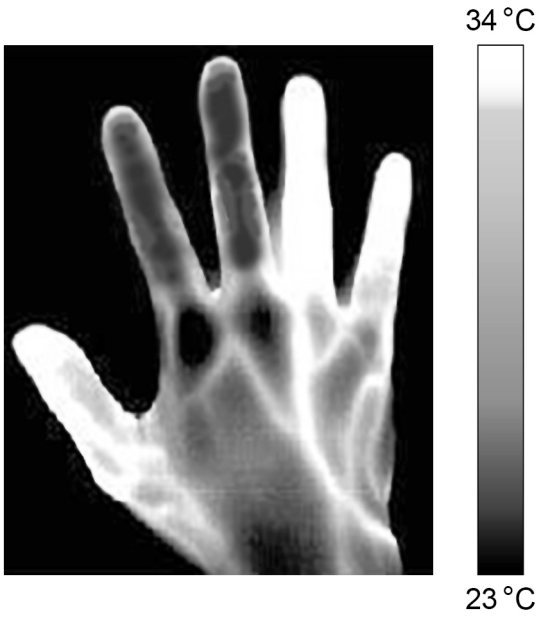
Question 07

November 2021 | 8464/P/2H | Original Q5

0 5 Different parts of the electromagnetic spectrum are used in medical imaging.

Figure 8 shows an image of a person's hand taken with an infrared camera.

Figure 8



0 5 . 1 Explain why the infrared camera is able to show that parts of the hand are at different temperatures.

[2 marks]

Question 5 continues on the next page

6.1.1.2 Changes in energy

Question 07 · continued

0 5 . 2 Infrared has a range of wavelengths from 700 nm to 1 mm.

Which part of the electromagnetic spectrum would have waves with a wavelength of 6.5×10^{-7} m?

[1 mark]

Tick (✓) **one** box.

- Infrared ☐
- Microwaves ☐
- Radio waves ☐
- Visible light ☐

6.1.1.2 Changes in energy

Question 07 · continued

0 5 . 3 **Figure 9** shows X-rays and gamma rays being used for medical imaging.

Figure 9

X-rays **Gamma rays**



To use X-rays for medical imaging, a machine produces a very brief burst of X-rays.

To use gamma rays for medical imaging, a radioactive isotope is injected into the patient's blood. The isotope is circulated around the body in the blood. The isotope emits gamma rays.

Compare the potential risks to a patient of using X-rays and gamma rays for medical imaging.

[4 marks]

Question 5 continues on the next page

6.1.1.2 Changes in energy

Question 07 · continued

X-rays are produced by colliding high-energy electrons into a metal target.

The electrons have high energy because they are accelerated to high speeds.

Only a small proportion of the kinetic energy of an electron is converted into an X-ray when it collides with the metal target.

0 5 . 4 An electron is accelerated through a distance of 15 mm.

The work done on the electron is 1.2×10^{-13} J.

Calculate the force on the electron.

[3 marks]

Force = _____ N

0 5 . 5 The metal target is made from tungsten.

Tungsten has the highest melting point of any metal.

Explain why using tungsten as the metal target enables the X-ray machine to be more powerful.

[3 marks]

13

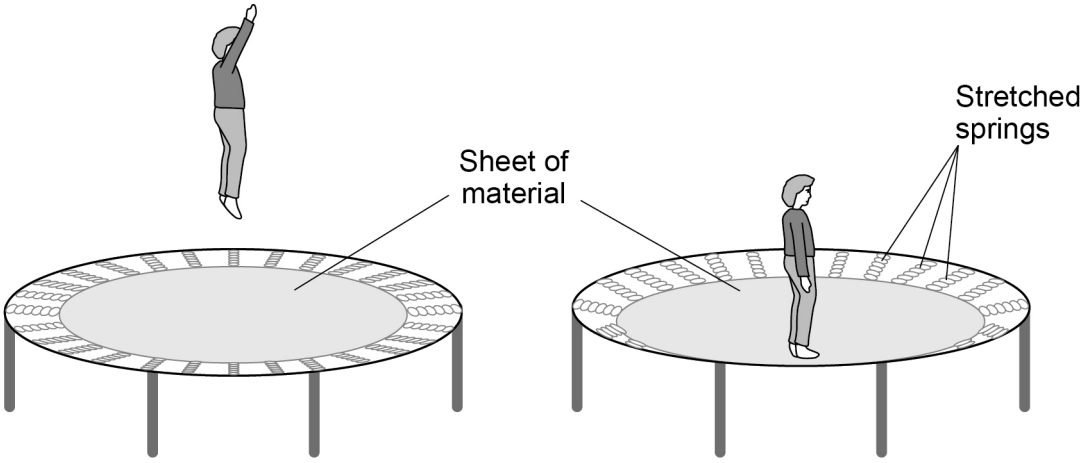
6.1.1.2 Changes in energy

Question 08

0 3 A trampoline is made from a sheet of material held in place by stretched springs.

Figure 5 shows a child on a trampoline.

Figure 5



6.1.1.2 Changes in energy

Question 08 · continued

0 3 . 1 Position **A** shows the child's maximum height above the trampoline.

Position **B** shows the lowest position reached by the child when landing on the trampoline.

Describe the changes to the stores of energy of the:

- child
- springs
- surroundings

as the child moves from position **A** to position **B**.

[4 marks]

Child _____

Springs _____

Surroundings _____

Question 3 continues on the next page

Question 08 · continued

0 3 . 2 When the child is at position **A**, each trampoline spring is stretched by 0.056 m

The elastic potential energy of each spring is 4.9 J

When the child is at position **B**, the elastic potential energy of each spring increases to 8.1 J

Calculate the extension of each spring when the child is at position **B**.

Use the Physics Equations Sheet.

[5 marks]

Extension = _____ m

0 3 . 3 As the child bounces on the trampoline the child does work.

What is the work done by the child equal to?

[1 mark]

Tick (✓) **one** box.

- The average force applied by the child ☐
- The maximum force applied by the child ☐
- The total energy store of the child ☐
- The total energy transferred by the child ☐

10

6.1.1.2 Changes in energy

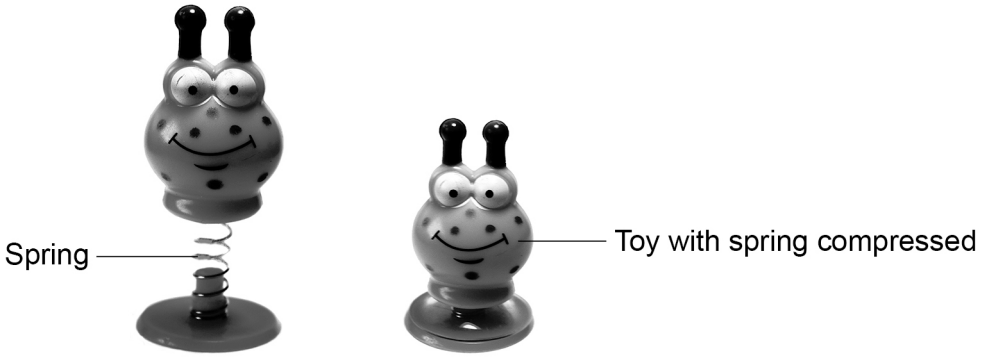
Question 09

June 2023 | 8464/P/1H | Original Q5

0 5 **Figure 10** shows a child's toy.

A child pushes down on the toy to compress the spring. The spring then launches the toy into the air.

Figure 10



Question 09 · continued

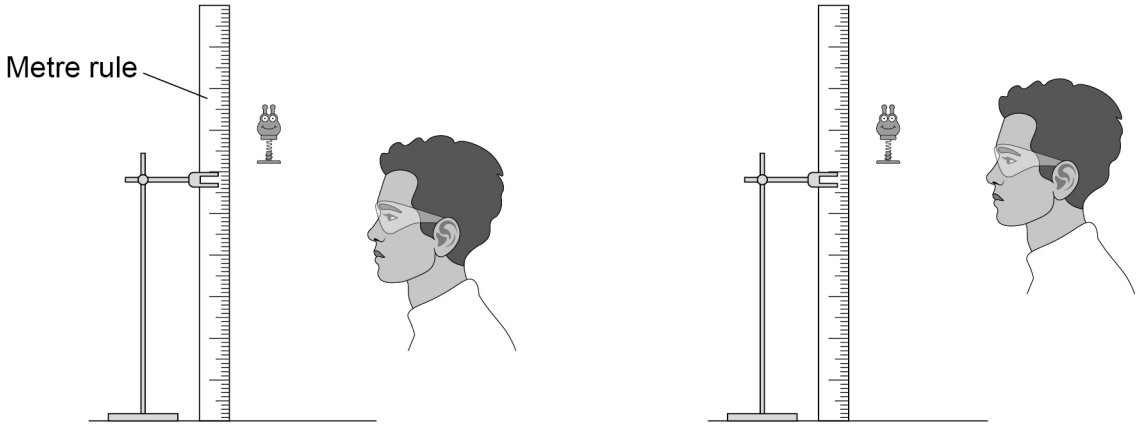
0 5 . 1 A student measured the maximum height reached by the toy.

The student placed a vertical metre rule near the toy, and observed the height reached by the toy.

The student repeated the experiment, observing from a different position.

Figure 11 shows the toy at its maximum height and the two positions of the student.

Figure 11



Observing the toy from **position B** instead of **position A** affected the measurement of the maximum height reached by the toy.

Explain how.

[2 marks]

Question 5 continues on the next page

6.1.1.2 Changes in energy

Question 09 · continued

0 5 . 2 The greatest height reached by the toy was 64 cm.

The gravitational potential energy of the toy at this height was 0.049 J.

gravitational field strength = 9.8 N/kg

Calculate the mass of the toy.

Use the Physics Equations Sheet.

Give your answer to 2 significant figures.

[5 marks]

Mass of toy (2 significant figures) = _____ kg

0 5 . 3 When the spring launches the toy into the air, the temperature of the air increases.

Explain why the child's toy on its own is **not** a closed system.

[2 marks]

9

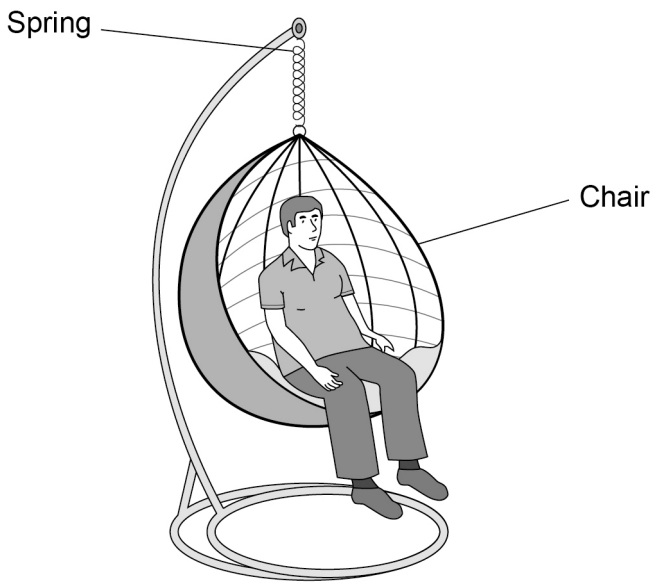
6.1.1.2 Changes in energy

Question 10

June 2023 | 8464/P/2H | Original Q5

0 5 **Figure 8** shows a garden chair hanging from a spring.

Figure 8



0 5 . 1 Which of the following describes the relationship between the weight (W) acting on the spring and the extension (e) of the spring?

[1 mark]

Tick (✓) **one** box.

$W = e$ ☐

$W \propto e$ ☐

$W \sim e$ ☐

$W < e$ ☐

6.1.1.2 Changes in energy

Question 10 · continued

0 5 . 2 The person in **Figure 8** has a weight of 750 N.

The person's weight causes the spring to extend by 60 mm.

Calculate the spring constant of the spring.

Use the Physics Equations Sheet.

[3 marks]

Spring constant = _____ N/m

Question 5 continues on the next page

Question 10 · continued

The manufacturer of the chair tests a new spring to see if it is suitable to hang the chair.

The spring can store a maximum of 1800 J of elastic potential energy before it becomes inelastically deformed.

0 5 . 3 Describe what is meant by 'inelastically deformed'.

[2 marks]

0 5 . 4 Calculate the maximum extension of the spring before the spring becomes inelastically deformed.

spring constant = 225 N/m

Use the Physics Equations Sheet.

[3 marks]

Maximum extension = _____ m

6.1.1.2 Changes in energy

Question 10 · continued

0 5 . 5 Evaluate the suitability of the new spring to hang the chair.

maximum elastic potential energy = 1800 J

spring constant = 225 N/m

weight of person = 750 N

distance between the bottom of the chair and the ground = 30 cm

Include a calculation in your answer.

Use the Physics Equations Sheet.

[3 marks]

12

6.1.1.2 Changes in energy

Question 11

June 2024 | 8464/P/1H | Original Q4

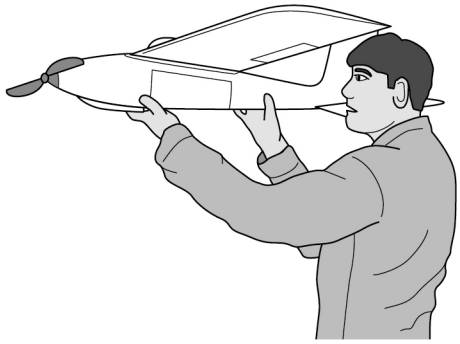
0 4 A drone is a miniature aircraft that has a remote control.

An inventor designed a battery powered drone.

The inventor tested what would happen if the battery runs out of charge during a flight.

Figure 5 shows the inventor about to launch the drone.

Figure 5



0 4 . 1 After the drone was launched, it moved at a constant speed and gained height.

The thermal stores of energy of the drone increased.

Describe **two** other changes to the energy stores of the drone as it moved at a constant speed and gained height.

[2 marks]

1 _____

_____

2 _____

_____

Question 4 continues on the next page

Question 11 · continued

When the drone reached a height of 840 m the motor was switched off.

The motor was switched back on after a short time, when the drone had fallen to a lower height above the ground.

The change in gravitational potential energy of the drone during the fall to this lower height was 3920 J.

The mass of the drone is 2.5 kg.

gravitational field strength = 9.8 N/kg

0 4 . 2 Calculate the height above the ground of the drone when the motor was switched back on.

Use the Physics Equations Sheet.

[4 marks]

Height above ground = _____ m

6.1.1.2 Changes in energy

Question 11 · continued

0 4 . 3 When the motor was switched off, the kinetic energy of the drone was 150 J.

Calculate the maximum possible speed of the drone when the motor was switched back on.

Use the Physics Equations Sheet.

Give your answer in km/s.

[5 marks]

Maximum possible speed of drone = _____ km/s

11

6.1.1.2 Changes in energy

Question 12

June 2024 | 8464/P/2H | Original Q2

0 2 **Figure 2** shows an Olympic gymnast performing a floor routine.

Figure 2



The floor contains springs.

When the gymnast lands on the floor, a force compresses the springs in the floor.

0 2 . 1 When a spring is compressed, the elastic potential energy of the spring increases.

Explain why compressing the springs in the floor helps the gymnast to jump higher.

Use ideas about energy in your answer.

[2 marks]

Question 2 continues on the next page

6.1.1.2 Changes in energy

Question 12 · continued

0 2 . 2 When the gymnast lands on the floor, one of the springs compresses by 1.2 cm.

spring constant = 8500 N/m

Calculate the elastic potential energy stored in the spring.

Use the Physics Equations Sheet.

Give the unit.

[4 marks]

Elastic potential energy = _____ Unit _____

Question 12 · continued

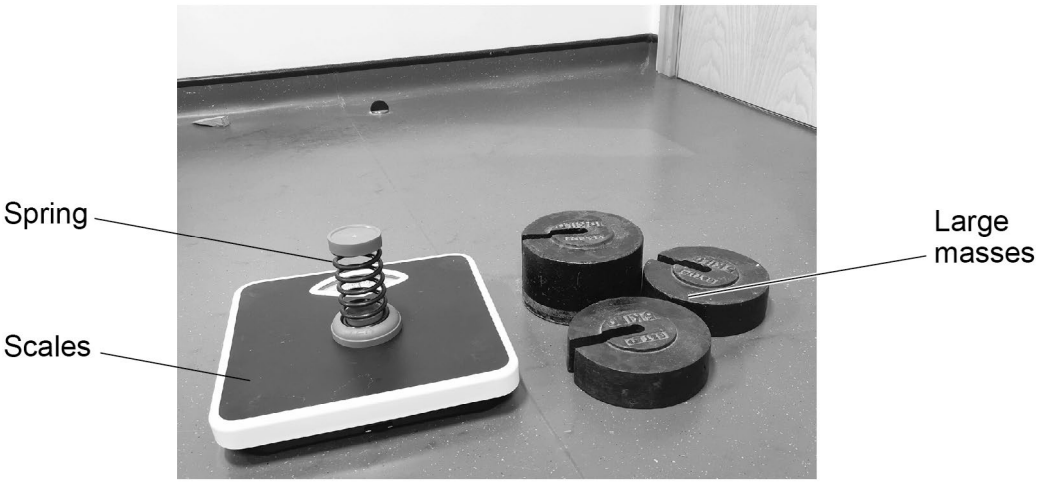
A student investigated a spring with a different spring constant.

When masses are placed on the spring it compresses.

The student measured the compression of the spring for different masses.

Figure 3 shows some of the equipment used.

Figure 3



0 2 . 3 Describe how the compression of the spring could be determined.

[2 marks]

0 2 . 4 Explain why the investigation should be done on the laboratory floor rather than on a table.

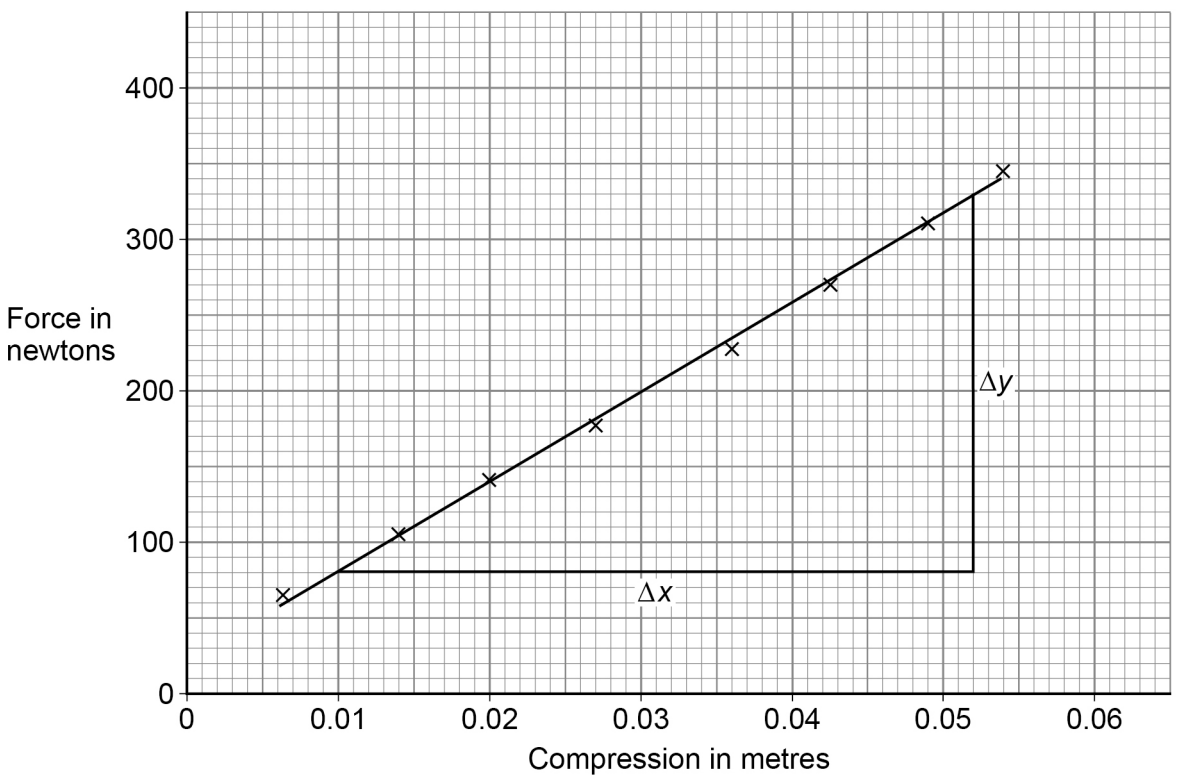
[2 marks]

6.1.1.2 Changes in energy

Question 12 · continued

Figure 4 shows the results.

Figure 4



6.1.1.2 Changes in energy

Question 12 · continued

The spring constant is the gradient of the line of best fit shown on **Figure 4**.

0 2 . 5 Determine the value Δy on **Figure 4**.

[1 mark]

$\Delta y =$ _____ N

0 2 . 6 Determine the value Δx on **Figure 4**.

[1 mark]

$\Delta x =$ _____ m

0 2 . 7 Determine the spring constant of the spring.

Use your answers to Question **02.5** and Question **02.6**.

Give your answer to 3 significant figures.

[2 marks]

Spring constant (3 significant figures) = _____ N/m

14