10 A force F was applied to compress a spring by a distance x.

A second spring of double the stiffness was compressed by the same distance x.

Which of the following gives the magnitude of the force applied to the second spring?

- ☒ **A** $4F$
- ☒ **B** $2F$
- ☒ **C** F
- ☒ **D** $\frac{F}{2}$

(Total for Question 10 = 1 mark)

7 A student applies a force to stretch a thin metal wire.

Which of the following describes the wire at the elastic limit?

- ☒ **A** The wire is elastically deformed.
- ☒ **B** The wire is plastically deformed.
- ☒ **C** The wire is at its maximum extension.
- ☒ **D** The wire snaps.

(Total for Question 7 = 1 mark)

6 Sea shells are the protective outer casing of some sea creatures. The shell is left behind when the creature dies and the shell is moved around on the seabed by the tides and waves.



Shells washed up on the beach are found to be as smooth as when the creature was alive.

This is because the material from which the shell is made is

- ☒ **A** hard.
- ☒ **B** stiff.
- ☒ **C** strong.
- ☒ **D** tough.

(Total for Question 6 = 1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

7 One end of a 50 cm length of wire is attached to a support. A load is attached to the free end of the wire, which extends by 2 mm.

Which of the following is the strain for the length of wire?

☒ **A** 0.004

☒ **B** 0.04

☒ **C** 25

☒ **D** 250

(Total for Question 7 = 1 mark)

4 A spring is stretched beyond its elastic limit. The applied force is then removed.

Which of the following describes the behaviour of the spring?

☒ **A** The extension of the spring is always proportional to the force applied.

☒ **B** Plastic deformation occurs until the spring reaches its elastic limit.

☒ **C** The spring only shows elastic deformation.

☒ **D** The spring does not return to its original length.

(Total for Question 4 = 1 mark)

6 When a force F is applied to a spring of stiffness k, the extension of the spring is Δx.

A force $2F$ is applied to a second spring of stiffness $3k$.

Which of the following expressions gives the extension of the second spring?

☒ **A** $\frac{2}{3}\Delta x$

☒ **B** $\frac{3}{2}\Delta x$

☒ **C** $\frac{1}{6}\Delta x$

☒ **D** $6\Delta x$

(Total for Question 6 = 1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

10 On a guitar two strings are tightened to the same tension. The diameter of one string is double the diameter of the other.

The stress in the thicker string is σ.

What is the stress in the thinner string?

☒ **A** 4σ

☒ **B** 2σ

☒ **C** $\frac{\sigma}{2}$

☒ **D** $\frac{\sigma}{4}$

(Total for Question 10 = 1 mark)

9 Concrete is used in both the spans and the supporting columns in a bridge. The spans need to be reinforced with steel but the supporting columns do not.



This is because concrete is

☒ **A** strong under both tension and compression.

☒ **B** strong under tension and weak under compression.

☒ **C** weak under both tension and compression.

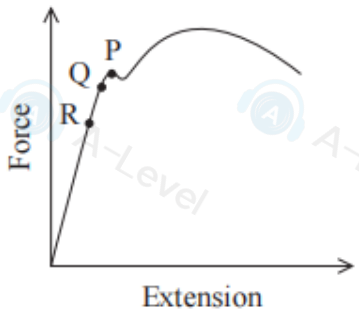
☒ **D** weak under tension and strong under compression.

(Total for Question 9 = 1 mark)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

9 A length of steel wire is fixed at one end. An increasing force is applied to the other end of the wire. The force extension graph for the wire is shown.



Which row of the table identifies points P, Q and R on the graph?

	P	Q	R
☐ **A**	elastic limit	limit of proportionality	yield point
☐ **B**	elastic limit	yield point	limit of proportionality
☐ **C**	yield point	elastic limit	limit of proportionality
☐ **D**	yield point	limit of proportionality	elastic limit

(Total for Question 9 = 1 mark)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Questions 8 and 9 refer to the information below.

A student carried out an experiment to determine the Young modulus of a material in the form of a wire. The original length and diameter of the wire were measured. A load was applied to the wire and the corresponding extended length was measured.

8 Which of the following combinations of original length and diameter would produce the greatest extension for a given load?

	Original length	Diameter
☒ **A**	long	large
☒ **B**	long	small
☒ **C**	short	large
☒ **D**	short	small

(Total for Question 8 = 1 mark)

9 The diameter of the wire was measured using a micrometer and found to be 0.35 mm. The micrometer reads to the nearest 0.01 mm.

Which of the following is the most appropriate percentage uncertainty to use with this measurement?

☒ **A** 2.9%

☒ **B** 5.8%

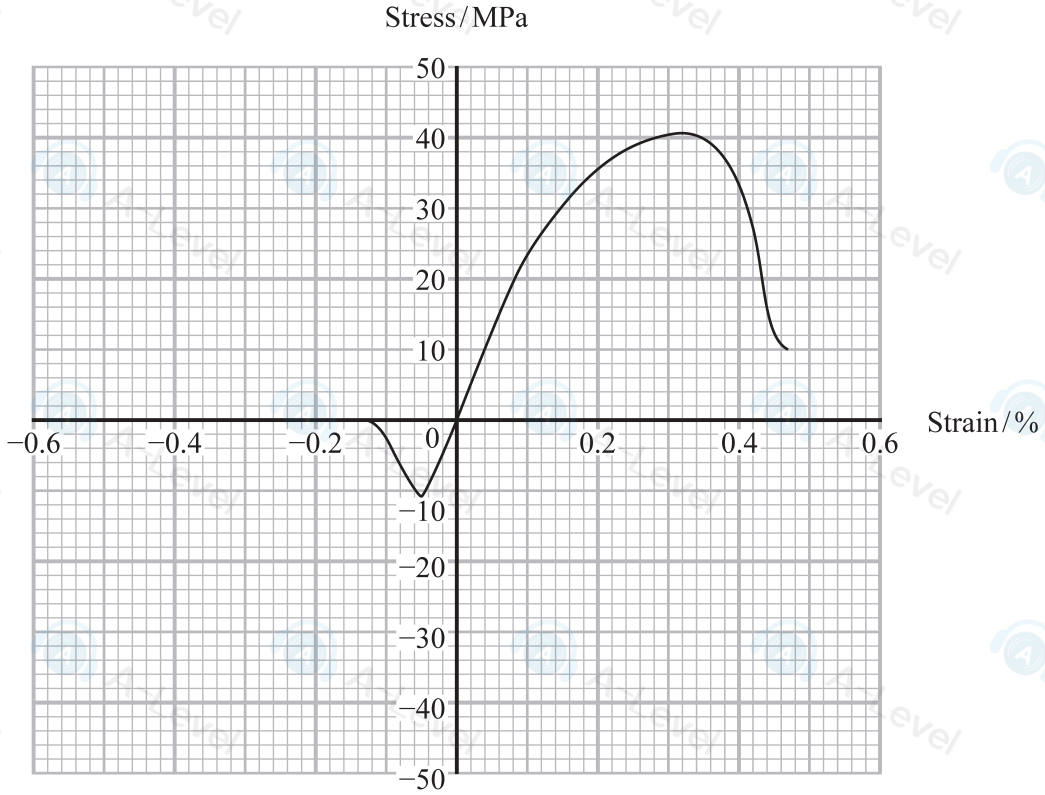
☒ **C** 3%

☒ **D** 6%

(Total for Question 9 = 1 mark)

16 Concrete is a material often used for building.

A stress-strain graph for one type of concrete is shown. Positive values of strain represent compression and negative values of strain represent tension.



(a) Explain how the stress-strain graph shows that concrete is more suitable for use under compression than under tension.

(2)

.....

.....

.....

.....

.....

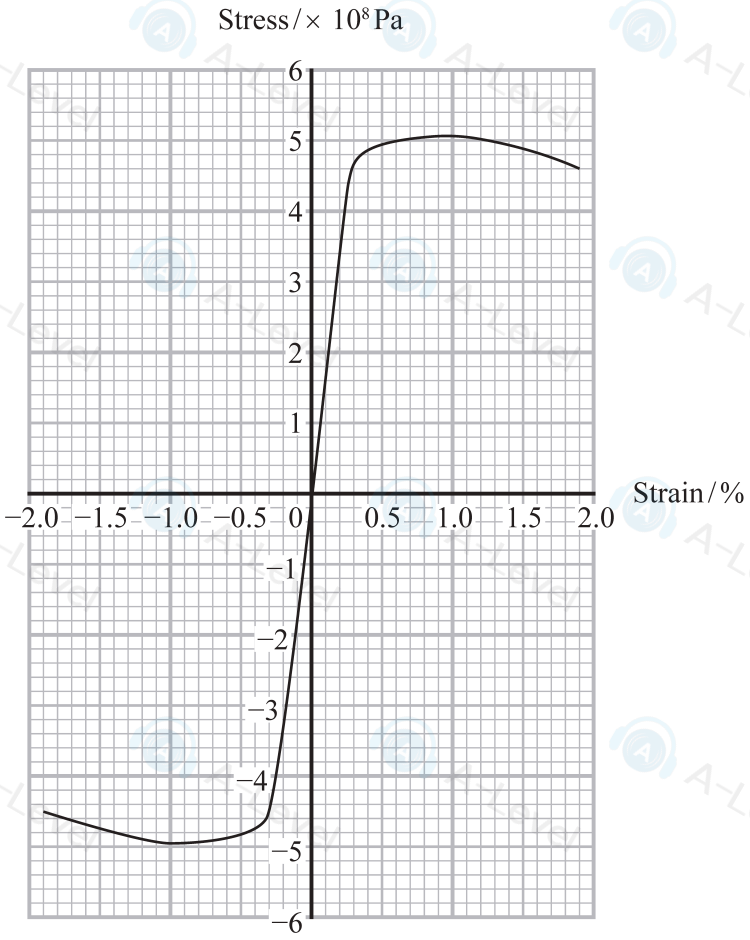
.....

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b) Steel is a metal often used in building. The stress-strain graph for steel is shown.



A steel rod has a diameter of 45 mm.

Calculate the maximum force that could be applied to the steel rod before it fractures.

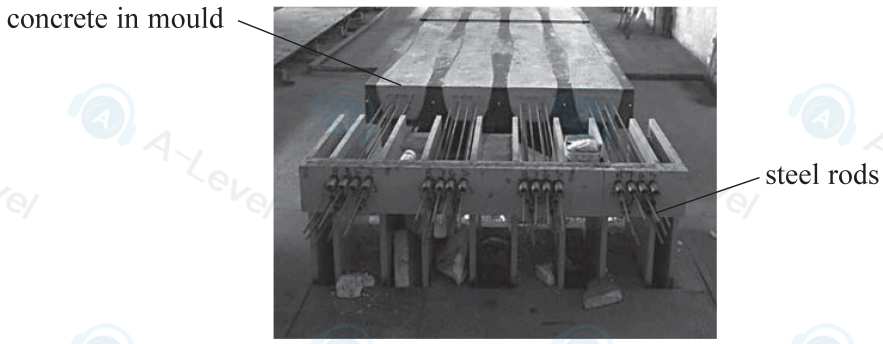
(3)

Maximum force = ...

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(c) To make concrete suitable for use under large forces steel rods are sometimes embedded in the concrete.

An external tensile force is applied to the steel rods. Concrete is poured into a mould around the rods. Once the concrete has set the external force is removed from the steel rods, placing the concrete in compression.



Source: www.designingbuildings.co.uk

(i) Explain how this process increases the maximum tensile force that the concrete can withstand before fracture.

(4)

(ii) Explain why the external tensile force in the rods must not take the steel beyond its elastic limit.

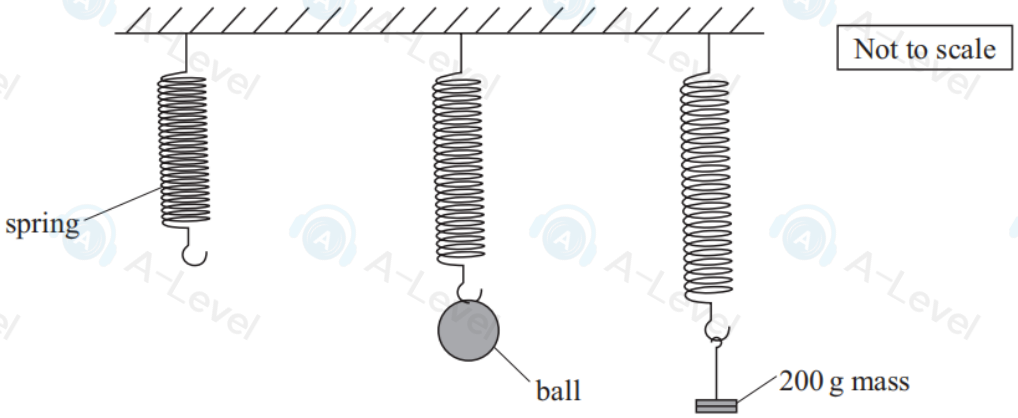
(2)

(Total for Question 16 = 11 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

15 A student investigated a spring.

The student measured the unstretched length of the spring. The student suspended different objects from the spring, as shown. She measured the new length of the spring each time.



(a) The unstretched length of the spring was 0.250 m.

When the ball was suspended from the spring, the length of the spring was 0.295 m.

When the 200 g mass was suspended from the spring, the length of the spring was 0.375 m.

Calculate the weight of the ball.

(4)

.....

.....

.....

.....

.....

.....

.....

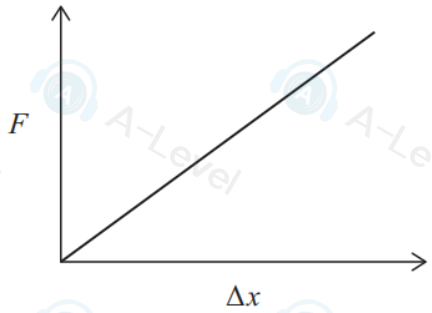
.....

Weight of ball = ...

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AR

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

(b) The sketch graph shows how the extension Δx of the spring varies with the total force F on the spring.



Explain why the elastic strain energy stored by the spring is proportional to F^2.

(3)

.....

.....

.....

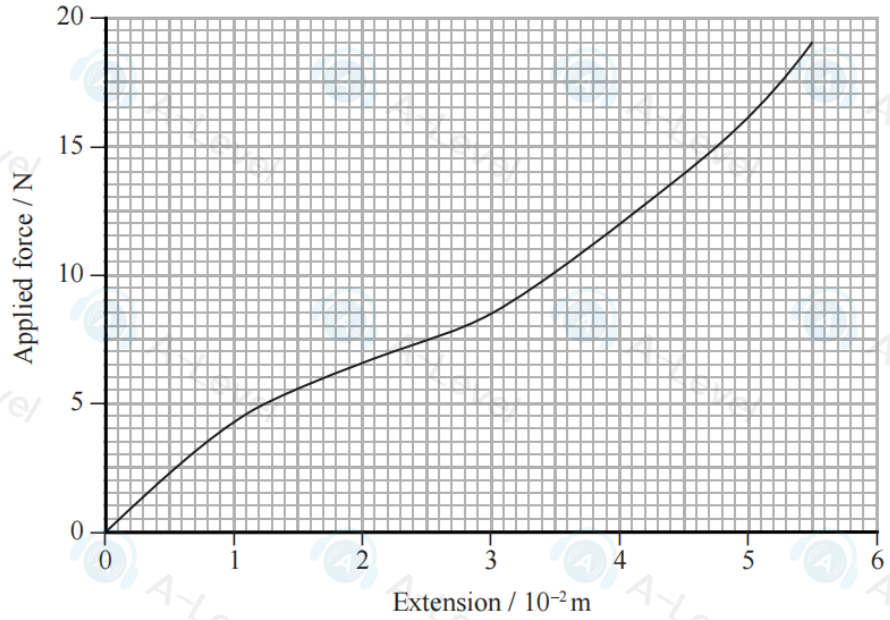
.....

.....

.....

(Total for Question 15 = 7 marks)

14 A student carried out an experiment to measure the extension of a rubber band. She determined the extension of the rubber band as the applied force was increased. She plotted a graph of the results.



(a) Determine the work done in stretching the rubber band.

(3)

Work done = ...

(b) Sketch, on the axes above, a possible graph for the unloading of the rubber band.

(2)

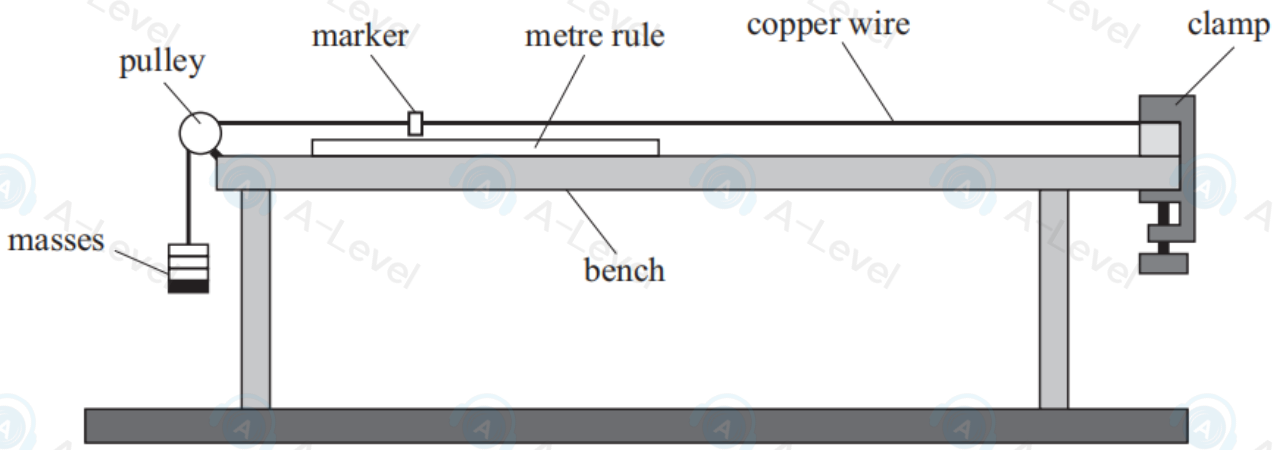
(Total for Question 14 = 5 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

16 A student carried out an experiment to determine the Young modulus of copper.

*(a) The student clamped one end of a copper wire to the bench. The wire passed over a pulley and masses were added to the other end of the wire.

A metre rule was fixed to the bench and a marker fixed to the wire, as shown.



The student measured the diameter of the copper wire.

Describe the other measurements that need to be made using this apparatus and how they will be used to determine the Young modulus of copper.

You should define the meanings of any symbols you use.

(6)

(b) Another student attaches a weight of 5.0 N to a copper wire of diameter 0.56 mm.

Calculate the extension of the wire.

length of wire = 2.5 m
Young modulus of copper = 1.1×10^{11} Pa

(4)

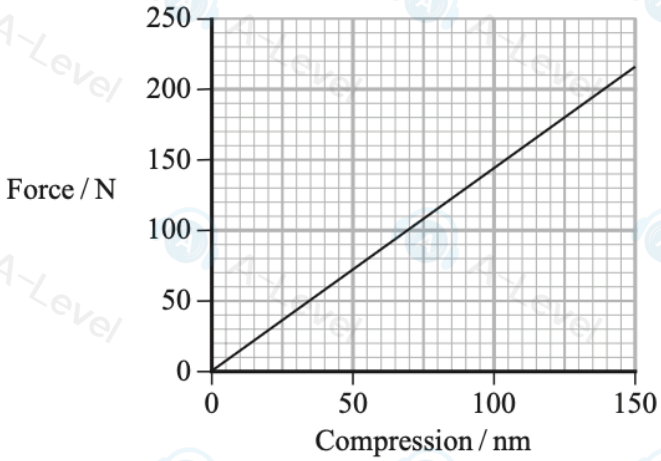
Extension = ...

(Total for Question 16 = 10 marks)

15: A builder uses bricks to build a wall.

As the wall gets taller, the force on a brick at the bottom of the wall increases.

A force-compression graph for this brick is shown.



(a) Determine the increase in elastic strain energy in the brick as the force increases from 85 N to 140 N.

(3)

.....

.....

.....

.....

.....

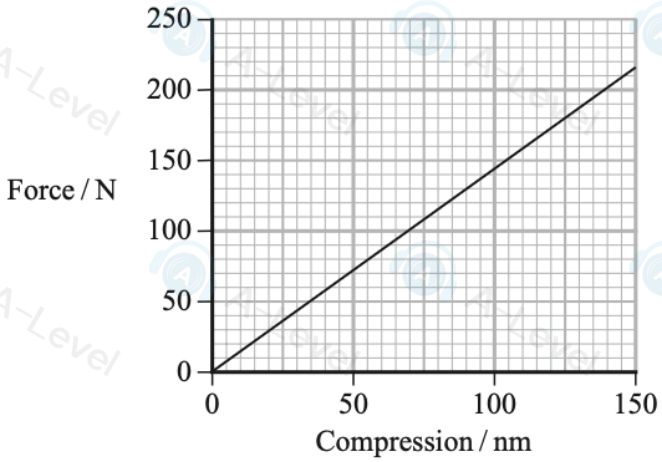
Increase in elastic strain energy = ...

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

15: A builder uses bricks to build a wall.

As the wall gets taller, the force on a brick at the bottom of the wall increases.

A force-compression graph for this brick is shown.



(a) Determine the increase in elastic strain energy in the brick as the force increases from 85 N to 140 N.

(3)

Increase in elastic strain energy = ...

(b) The brick undergoes elastic deformation.

State what is meant by elastic deformation.

(1)

(Total for Question 15 = 4 marks)

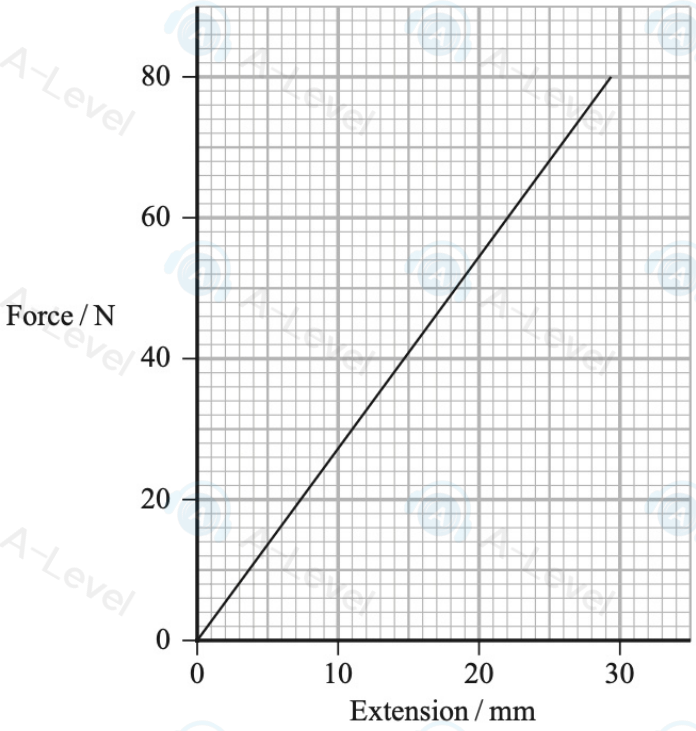
DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN TH

17: A violin is a musical instrument that has four strings, as shown.



(Source: © bob_sato_1973/Getty Images)

(a) A force-extension graph for a sample of one of the strings is shown below.



The table shows the stiffness for samples of three of the strings on the violin.

Each sample was the same original length as the sample used to obtain the graph.

String	Stiffness / N m^{-1}
X	1700
Y	2700
Z	6100

Deduce which string was used to obtain the force-extension graph.

(4)

.....

.....

.....

.....

.....

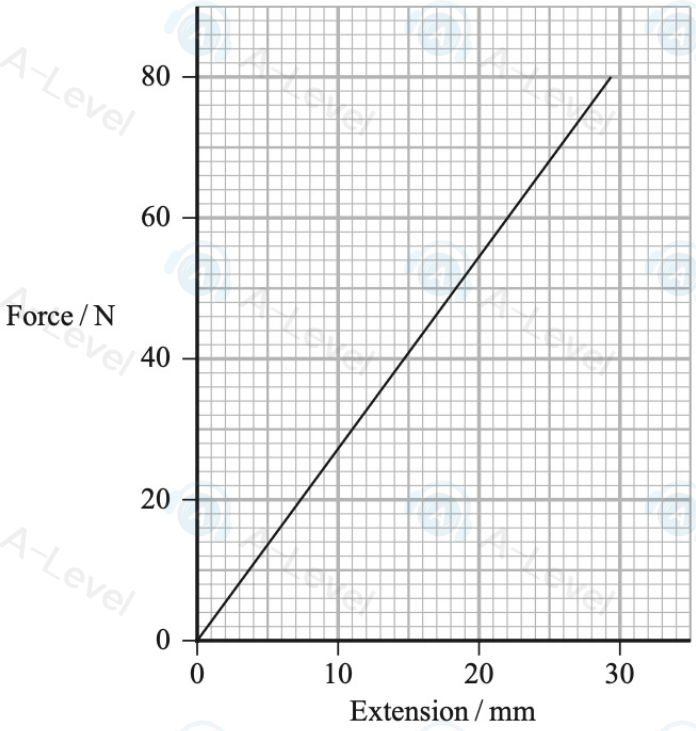
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

17: A violin is a musical instrument that has four strings, as shown.



(Source: © bob_sato_1973/Getty Images)

(a) A force-extension graph for a sample of one of the strings is shown below.



The table shows the stiffness for samples of three of the strings on the violin.

Each sample was the same original length as the sample used to obtain the graph.

String	Stiffness / N m^{-1}
X	1700
Y	2700
Z	6100

Deduce which string was used to obtain the force-extension graph.

(4)

.....

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA