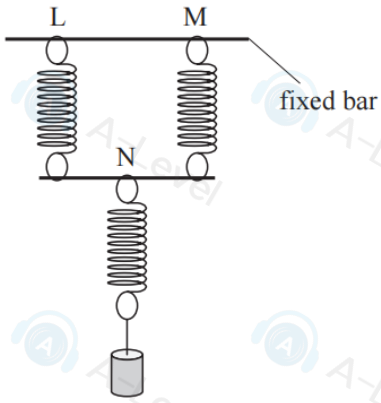
10 Three identical springs L, M and N are connected, as shown.
Spring N has a load attached to its lower end. The extension of spring L is x.



Which row of the table gives the extensions of the springs?

	Extension of L	Extension of M	Extension of N
☒ **A**	x	x	x
☒ **B**	x	$\frac{x}{2}$	x
☒ **C**	x	x	$\frac{x}{2}$
☒ **D**	x	x	$2x$

(Total for Question 10 = 1 mark)

Questions 8 and 9 refer to the information below.

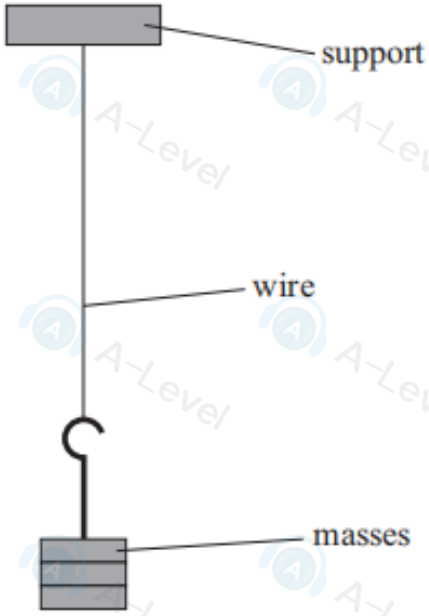
A student carried out an experiment to determine the Young modulus of a material in the form of a wire. The original length and diameter of the wire were measured. A load was applied to the wire and the corresponding extended length was measured.

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 A student attached one end of a wire to a support. The student added masses to the other end of the wire, as shown. The student measured the corresponding extension for each added mass.



The wire broke when the extension was small.

The student replaced the wire with a second wire made of the same material.
The second wire had a larger extension before breaking.

Which of the following produced this result?

☒ **A** The second wire had a greater diameter.

☒ **B** The second wire had a longer length.

☒ **C** The second wire had a smaller diameter.

☒ **D** The second wire had a shorter length.

(Total for Question 9 = 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)

DO NOT WRITE IN THIS

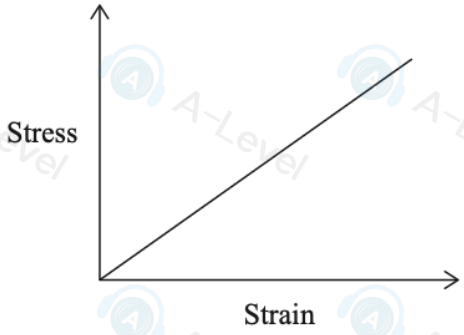
7 A student applies a force to stretch a thin metal wire.

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)

1 Stress is applied to a sample of a material. The stress is increased until the sample breaks. The graph shows the relationship between stress and strain for the sample.

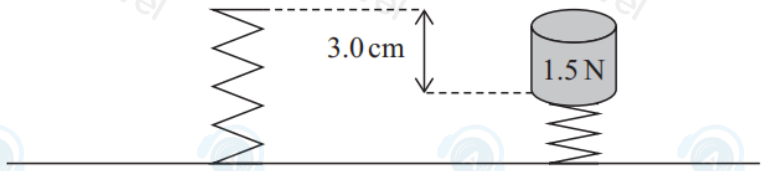


Which of the following gives the Young modulus of the material?

- ☒ **A** The area between the line and the strain axis.
- ☒ **B** The gradient of the graph.
- ☒ **C** The maximum stress multiplied by the maximum strain.
- ☒ **D** The maximum strain divided by the maximum stress.

(Total for Question 1 = 1 mark)

2 A cylinder of weight 1.5 N is placed on top of a vertical spring, and the spring compresses by 3.0 cm as shown.



What is the spring constant of the spring?

- **A** $0.02\,\text{N m}^{-1}$
- **B** $0.5\,\text{N m}^{-1}$
- **C** $2.0\,\text{N m}^{-1}$
- **D** $50\,\text{N m}^{-1}$

(Total for Question 2 = 1 mark)

3 A spring is stretched by applying a force of 3.0 N. The elastic strain energy stored by the spring is 0.04 J.

Which of the following expressions gives the extension, in m, of the spring?

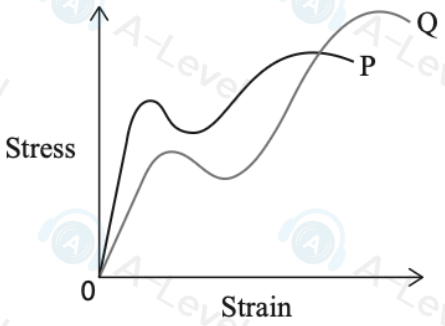
- ☒ **A** $\frac{2 \times 0.04}{3.0}$
- ☒ **B** $\sqrt{\frac{2 \times 0.04}{3.0}}$
- ☒ **C** $\sqrt{\frac{3.0}{2 \times 0.04}}$
- ☒ **D** $\frac{3.0}{2 \times 0.04}$

(Total for Question 3 = 1 mark)

DO NOT WRITE IN THIS AREA

9 A force is applied to stretch two wires, P and Q, until the wires break. Each wire is made of a different metal.

The stress-strain graph for each wire is shown.



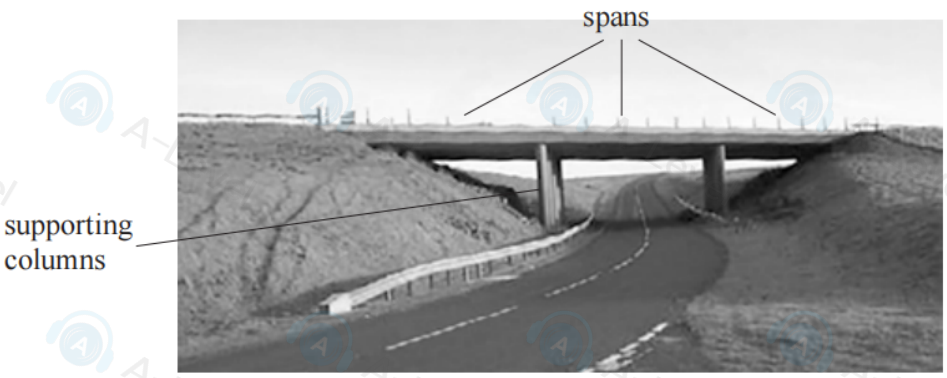
Which of the following statements is correct?

- ☒ **A** P has a greater breaking stress than Q.
- ☒ **B** P has a greater breaking strain than Q.
- ☒ **C** P has a greater yield stress than Q.
- ☒ **D** P has a lower Young modulus than Q.

(Total for Question 9 = 1 mark)

DO NOT WRITE IN THIS AREA

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)

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

She added a mass m to the free end of a sample of copper in the form of a long thin wire and the corresponding extension Δx was measured. This was repeated for increasing masses.

(a) State the meaning of the term Young modulus.

(1)

(b) The student repeated the measurement of the diameter of the wire at different positions and orientations of the wire.
She obtained the following results.

Diameter / mm	0.230	0.235	0.230	0.240

(i) Determine the cross-sectional area of the sample of wire used.

(3)

(ii) The student plotted a graph of m against Δx. She measured the gradient and obtained a value of $195\,\text{kg m}^{-1}$.

Determine the Young modulus of the copper.

length of sample of copper used = 3.50 m

(3)

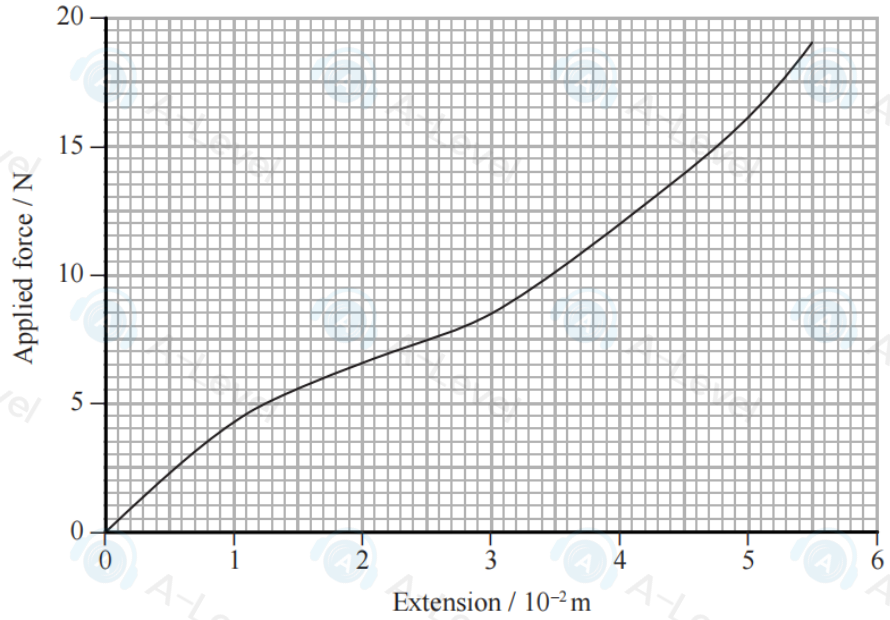
(iii) The experiment was repeated by another student, using a 2.00 m length of the copper wire.

Suggest how the values obtained for the gradient and hence the Young modulus will differ between the students.

(2)

(Total for Question 15 = 9 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 = ...

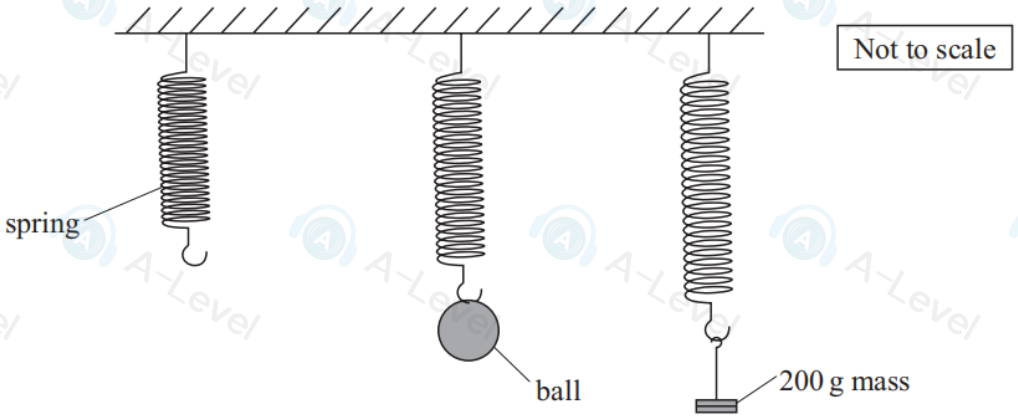
(b) Sketch, on the axes above, a possible graph for the unloading of the rubber band.

(2)

(Total for Question 14 = 5 marks)

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)

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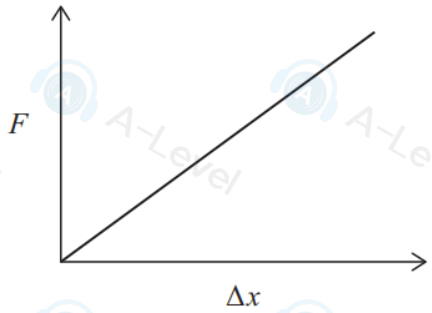
Weight of ball = ...

(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)

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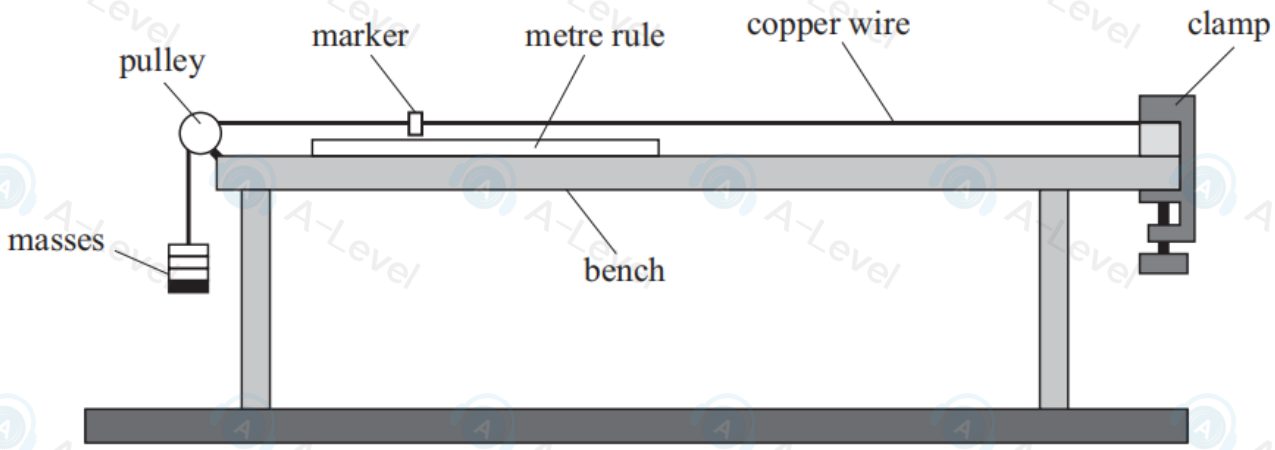
(Total for Question 15 = 7 marks)

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)

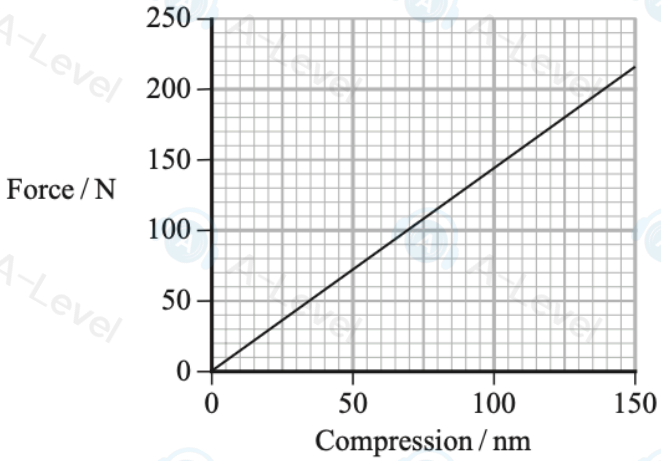
Extension = ...

(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)

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Increase in elastic strain energy = ...

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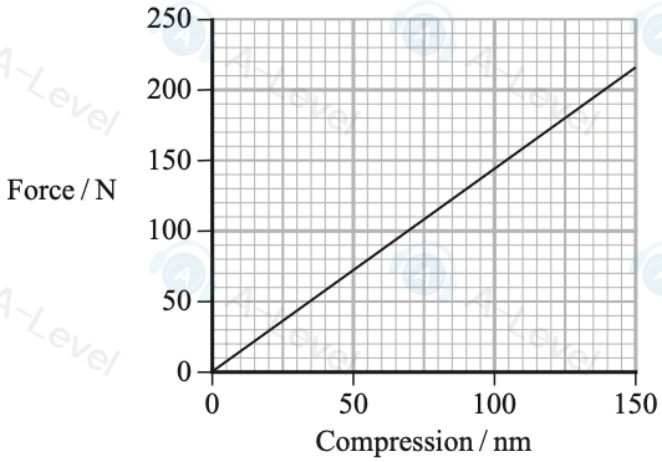


(a) Determine the increase in elastic strain energy in the brick as the force increases from 85 N to 140 N.

(3)

Increase in elastic strain energy = ...

(b) The brick undergoes elastic deformation.

State what is meant by elastic deformation.

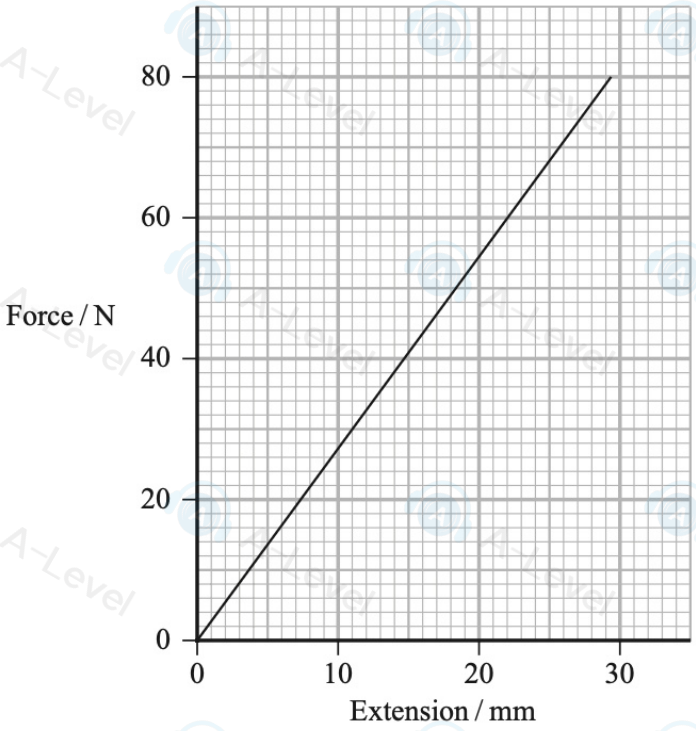
(1)

(Total for Question 15 = 4 marks)

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)

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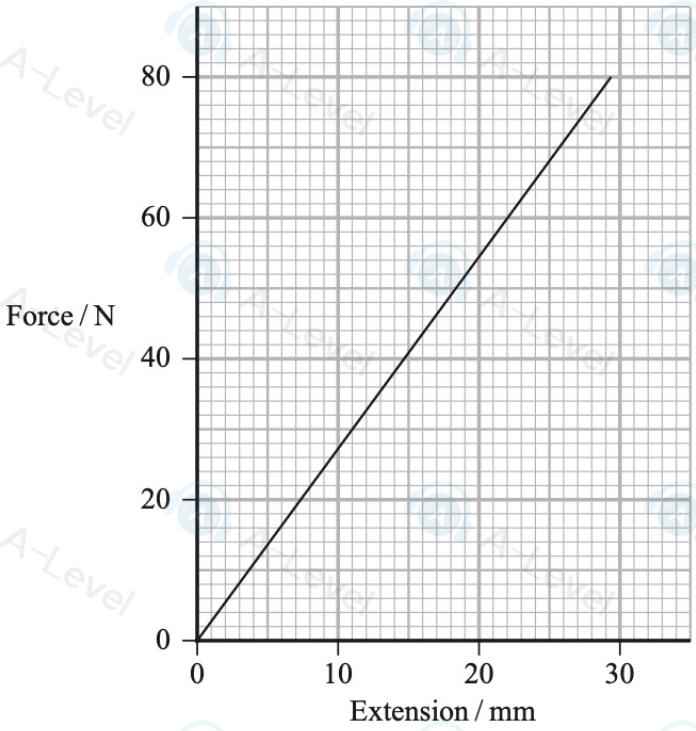

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Each sample was the same original length as the sample used to obtain the graph.

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

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

(4)

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