This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

SE01 Exam

10NOV2025

Do NOT write in this box. Your MARK will be placed here.

Subject :	A Level : Physics 1 : RB
Class :	11A and 12A
Teacher :	Dr Ruth Brett
Duration :	1 hour

Give your answers to an appropriate number of significant figures and write the unit if there is one. You should have a physics formula booklet.

You are to answer the questions to this exam on : This exam paper

Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

Section A
Each question is 1 mark.

1. 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?

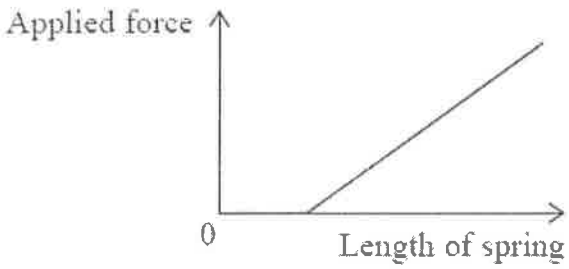
☐ **A** $4F$

☐ **B** $2F$

☐ **C** F

☐ **D** $\frac{F}{2}$

2. A force is applied to stretch a spring. The graph shows how the length of the spring varies with the applied force.



Which of the following gives the stiffness of the spring?

☐ **A** the area between the graph and the x-axis

☐ **B** the area between the graph and the y-axis

☐ **C** the gradient of the graph

☐ **D** $\frac{1}{\text{gradient of the graph}}$

3. Two identical springs are arranged in series. A force of 45.0 N is applied to the springs, as shown.



The springs extend a total distance of 15 mm.

Which of the following expressions gives the stiffness of each spring in N mm^{-1}?

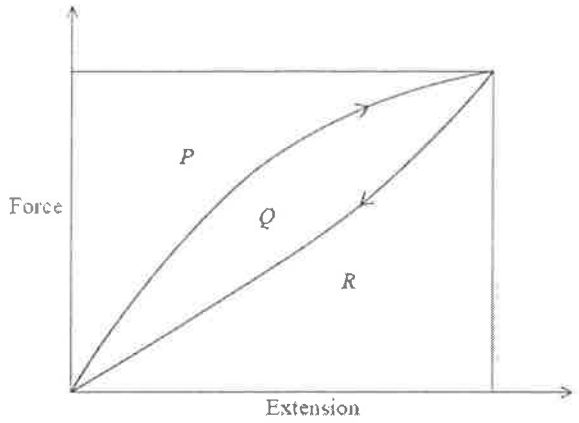
- ☐ **A** $\frac{15}{2 \times 45}$
- ☐ **B** $\frac{45}{2 \times 15}$
- ☐ **C** $\frac{2 \times 15}{45}$
- ☐ **D** $\frac{2 \times 45}{15}$

4. 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.

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

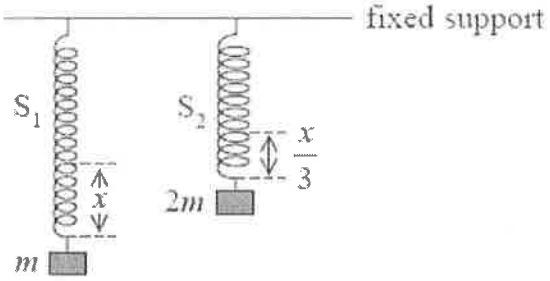
5. A rubber band is initially stretched by an increasing force. When the force is gradually decreased, the rubber band returns to its original length. The force-extension graph for the rubber band is shown.



P, *Q* and *R* represent different areas of the graph.
Which of the following gives the work done in stretching the rubber band up to its maximum extension?

- ☐ **A** $P + Q$
- ☐ **B** $Q + R$
- ☐ **C** R
- ☐ **D** Q

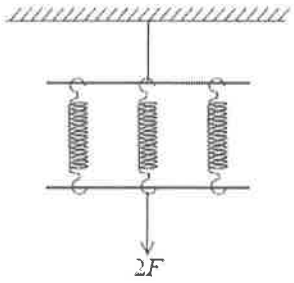
6. Two different springs, S_1 and S_2, are suspended from a fixed support. Masses are attached to the bottom of S_1 and S_2 as shown.



The extension of S_1 is x, and the extension of S_2 is $\frac{x}{3}$. The elastic strain energy in spring S_1 is E.
Which of the following is the elastic strain energy in spring S_2?

- ☐ **A** $6E$
- ☐ **B** $\frac{3E}{2}$
- ☐ **C** $\frac{2E}{3}$
- ☐ **D** $\frac{E}{6}$

7. When a certain spring is stretched by a tensile force F, the elastic energy stored in the spring is E. Three of these springs are arranged in parallel and stretched by a tensile force of $2F$, as shown.



Which of the following expressions gives the elastic energy stored in the parallel system?

☐ **A** $\frac{1}{3}E$

☐ **B** $\frac{2}{3}E$

☐ **C** $\frac{4}{3}E$

☐ **D** $2E$

8. When compressed by a force of 50 N, a spring had a length of 12.0 cm.
When compressed by a force of 70 N, the same spring had a length of 7.1 cm.
Which of the following expressions gives the stiffness k of the spring in N cm^{-1}?

☐ **A** $\frac{70}{12.0} - \frac{50}{7.1}$

☐ **B** $\frac{(70 - 50)}{(12.0 - 7.1)}$

☐ **C** $\frac{50}{7.1} - \frac{70}{12.0}$

☐ **D** $\frac{(70 - 50)}{(12.0 - 4.9)}$

9. 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

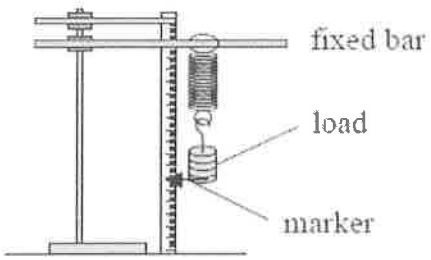
☐ **B** 0.04

☐ **C** 25

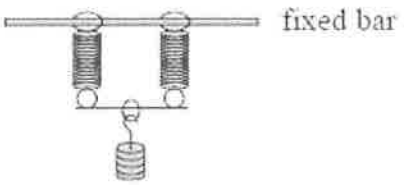
☐ **D** 250

(Total for question = 1 mark)

10. A student investigated Hooke's law using the equipment shown. As each additional load was added, the new position of a marker along a metre rule was recorded and the extension calculated.



The investigation was repeated with an additional identical spring, arranged as shown.



For a given applied load, which of the following statements is correct?

☐ **A** The extension is doubled because the spring constant is doubled.

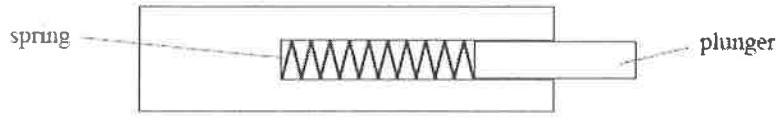
☐ **B** The extension is doubled because the spring constant is halved.

☐ **C** The extension is halved because the spring constant is doubled.

☐ **D** The extension is halved because the spring constant is halved.

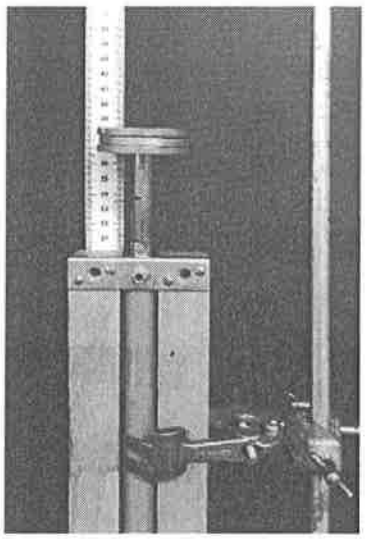
Section B

11. A school dynamics trolley has a plunger attached to a spring. When the plunger is pushed in, the spring is compressed. When the plunger is released, it is pushed back out by the spring.



(a) A student investigated the spring to determine whether it obeys Hooke's law in compression.

The trolley was placed vertically in front of a scale and weights were added in turn to the top of the plunger, as shown. The position of the end of the plunger was recorded each time.



The recorded results are shown in the table.

Weight / N	Position of plunger / cm	
0.00	37.3	
2.00	37.0	
4.00	36.6	
6.00	36.2	
8.00	35.9	
10.00	35.5	

(i) Use the results to plot a graph of weight on the y-axis against compression on the x-axis *(this is the **change in length**, like the extension, but it's getting shorter, so we call it compression instead of having a negative value)*. You may use the additional column for your processed data.

(5)

Plot the graph on the graph paper on the LAST page of this paper. You may remove it to plot the graph, but make sure you get it stapled back in (as the last page).

This question continues on the next page.

(ii) The student concluded that the spring obeys Hooke's law with a spring constant of about 600 N m^{-1}.

Determine whether the student's conclusion is justified.

(4)

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(Total for question = 9 marks)

12. Some spiders form silk in long, thin threads to catch flying insects.

The Darwin's bark spider can produce very long threads. A scientist investigated the properties of these threads.

The scientist applied forces to stretch threads of spider silk.

(a) The stress in one thread was 4.3 MPa. The radius of the thread was 1.9×10^{-6} m.

Calculate the force applied to the thread.

(3)

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Force = ...

(b) The scientist investigated a thread of length 25.0 m.

Determine the length of this thread when stretched to its limit of proportionality.
Young modulus of spider silk = 8.70 GPa
stress at limit of proportionality = 300 MPa

(4)

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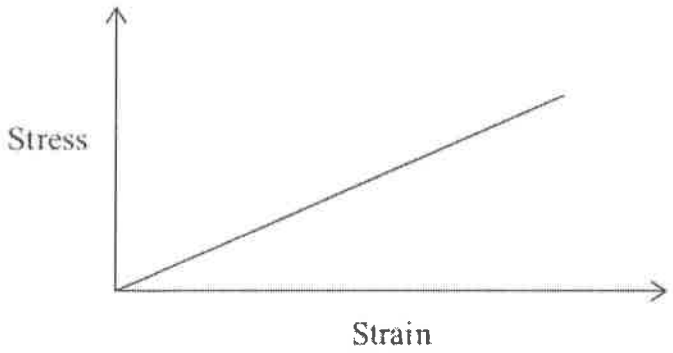
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Length at limit of proportionality = ...

(c) The table shows some properties of spider silk and a type of steel.

Material	Young modulus / GPa	Stress at limit of proportionality / MPa
Spider silk	8.70	300
Steel	200	350

(i) The sketch graph shows the stress-strain relationship for the spider silk up to its limit of proportionality.



Add a line to the sketch graph to show the stress-strain relationship for the steel up to its limit of proportionality.

(2)

(Total for question = 9 marks)

13. A crane supports a load of 950 N with a steel cable. If the breaking stress of steel is 500MPa, calculate the smallest **diameter** cable that can be used.

(3)

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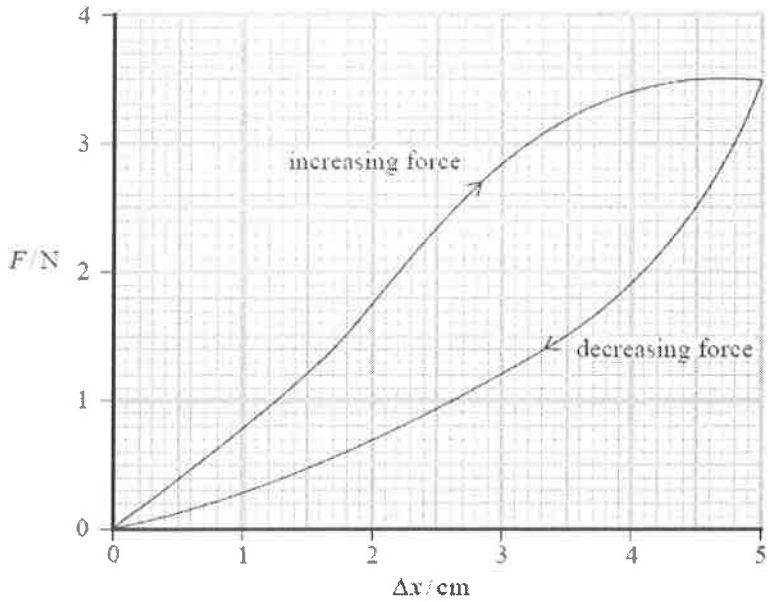
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Smallest diameter of cable = ...

(Total for question = 3 marks)

14. A student applied a force F to a rubber band. The student measured the corresponding extension, Δx, as F was increased and then decreased.

The graph shows how Δx varied as F was increased and then decreased.



(a) State how the graph shows that the rubber band deformed elastically.

(1)

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(b) The work done on the rubber band as F increased is greater than the work done by the rubber band as F was decreased.

There is a difference in these values because heating occurred.
Determine the energy that caused heating as F was increased and then decreased to zero.

(3)

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Energy that caused heating = ...

(Total for question = 4 marks)

15. Under certain conditions, many materials obey Hooke's law.

(a) State Hooke's law and describe the conditions under which it is valid.

(2)

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(b) Describe the behaviour of a spring when it is stretched beyond the region where Hooke's law is obeyed.

(2)

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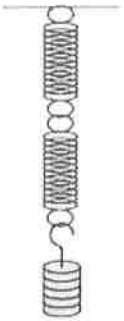
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(Total for question = 4 marks)

16. A student investigated the behaviour of a spring. Another student repeated the investigation using two new springs connected in series as shown.



The springs were identical to the spring used in the original investigation.
Explain why the spring constant for this arrangement of the springs would be half that for one spring.

(4)

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(Total for question = 9 marks)

17. A student carried out an experiment to determine the Young modulus of constantan.
The student had a constantan wire with cross-sectional area A of 3.97×10^{-7} m^2.
The unstretched length x of the wire was 4.00 m.

(a) The student had enough slotted masses to apply a weight of up to 150 N to the wire.

The breaking stress for constantan is about 420 MPa.
Deduce whether the wire could support a weight of 150 N.

(3)

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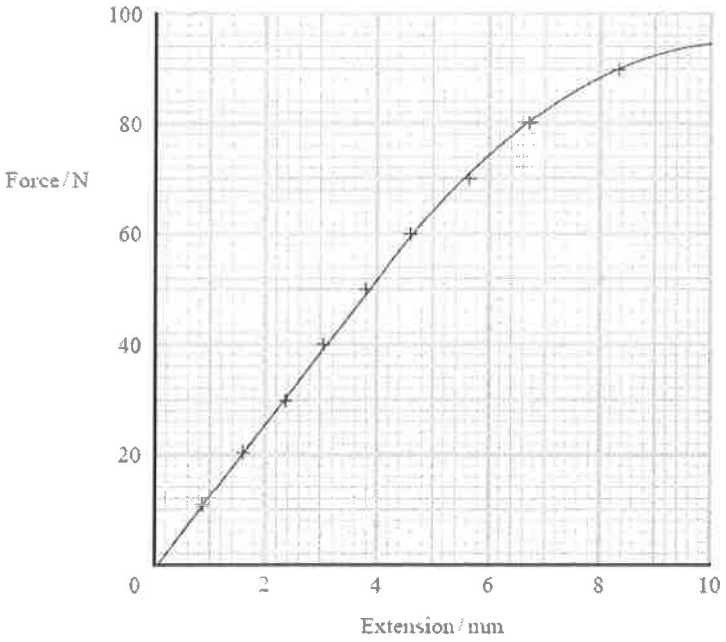
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(b) The student added slotted masses to the wire and determined the corresponding extensions. The student plotted a graph of force against extension, as shown.



(i) Show that the stiffness of the wire is about 1.3×10^4 N m^{-1}.

(2)

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(ii) The relationship between the stiffness k of the wire and the Young modulus E is given by

$$k = \frac{EA}{x}$$

where x is the unstretched length of the wire and A is the cross-sectional area of the wire. Determine a value for the Young modulus of constantan using the student's data.

(2)

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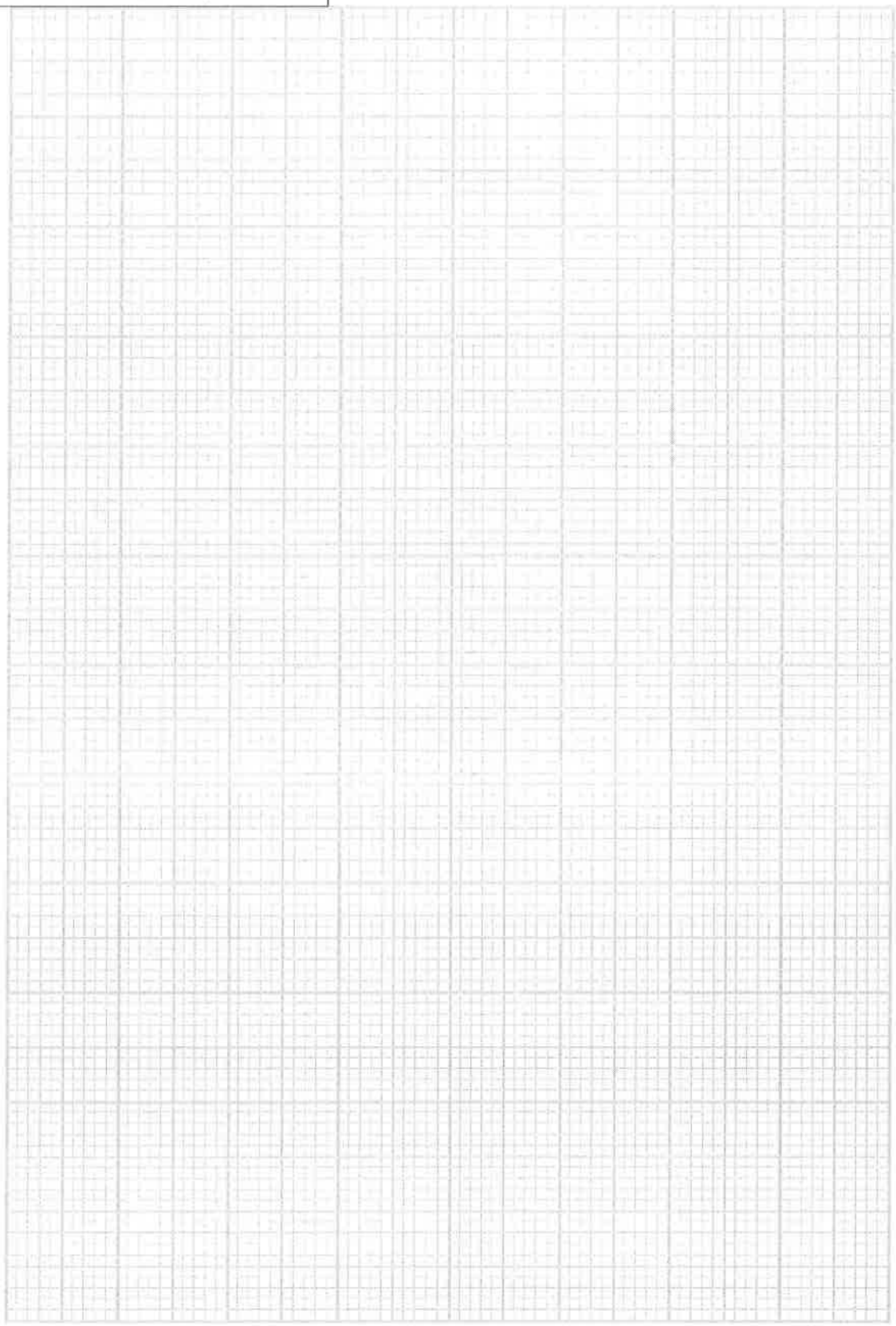
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Young modulus = ...

(Total for question = 7 marks)

Graph paper for Q11



For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

Section A
Each question is 1 mark.

1. 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?

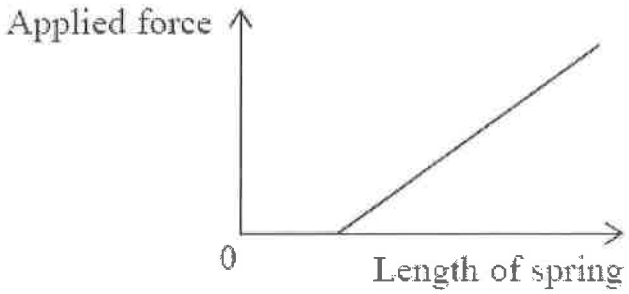
☐ **A** $4F$

☒ **B** $2F$

☐ **C** F

☐ **D** $\frac{F}{2}$

2. A force is applied to stretch a spring. The graph shows how the length of the spring varies with the applied force.



Which of the following gives the stiffness of the spring?

☐ **A** the area between the graph and the x-axis

☐ **B** the area between the graph and the y-axis

☒ **C** the gradient of the graph

☐ **D** $\frac{1}{\text{gradient of the graph}}$

3. Two identical springs are arranged in series. A force of 45.0 N is applied to the springs, as shown.



The springs extend a total distance of 15 mm.

Which of the following expressions gives the stiffness of each spring in N mm^{-1}?

☐ **A** $\frac{15}{2 \times 45}$

☐ **B** $\frac{45}{2 \times 15}$

☐ **C** $\frac{2 \times 15}{45}$

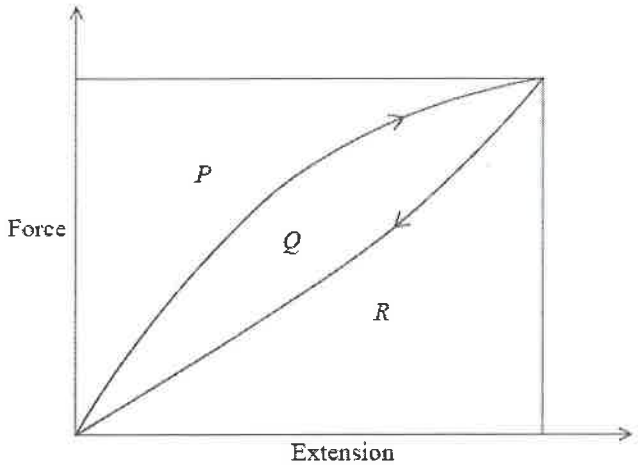
(1) ☒ **D** $\frac{2 \times 45}{15}$

4. 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.

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
(1) ☒ **B**	long	small
☐ **C**	short	large
☐ **D**	short	small

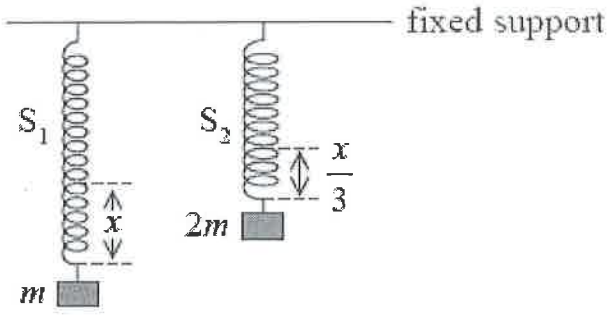
5. A rubber band is initially stretched by an increasing force. When the force is gradually decreased, the rubber band returns to its original length. The force-extension graph for the rubber band is shown.



P, Q and R represent different areas of the graph.
Which of the following gives the work done in stretching the rubber band up to its maximum extension?

- ☐ **A** $P + Q$
- ☒ **B** $Q + R$
- ☐ **C** R
- ☐ **D** Q

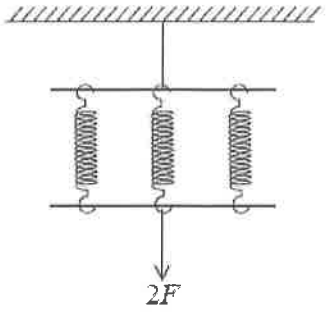
6. Two different springs, S_1 and S_2, are suspended from a fixed support. Masses are attached to the bottom of S_1 and S_2 as shown.



The extension of S_1 is x, and the extension of S_2 is $\frac{x}{3}$. The elastic strain energy in spring S_1 is E.
Which of the following is the elastic strain energy in spring S_2?

- ☐ **A** $6E$
- ☐ **B** $\frac{3E}{2}$
- ☒ **C** $\frac{2E}{3}$
- ☐ **D** $\frac{E}{6}$

7. When a certain spring is stretched by a tensile force F, the elastic energy stored in the spring is E. Three of these springs are arranged in parallel and stretched by a tensile force of $2F$, as shown.



Which of the following expressions gives the elastic energy stored in the parallel system?

☐ **A** $\frac{1}{3}E$

☐ **B** $\frac{2}{3}E$

(1) ☒ **C** $\frac{4}{3}E$

☐ **D** $2E$

8. When compressed by a force of 50 N, a spring had a length of 12.0 cm.
When compressed by a force of 70 N, the same spring had a length of 7.1 cm.
Which of the following expressions gives the stiffness k of the spring in N cm^{-1}?

☐ **A** $\frac{70}{12.0} - \frac{50}{7.1}$

(1) ☒ **B** $\frac{(70 - 50)}{(12.0 - 7.1)}$

☐ **C** $\frac{50}{7.1} - \frac{70}{12.0}$

☐ **D** $\frac{(70 - 50)}{(12.0 - 4.9)}$

9. 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?

(1)

☒ **A** 0.004

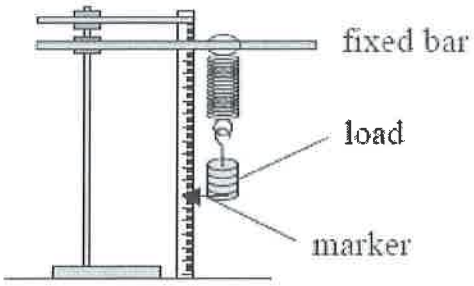
☐ **B** 0.04

☐ **C** 25

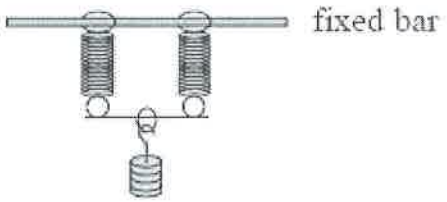
☐ **D** 250

(Total for question = 1 mark)

10. A student investigated Hooke's law using the equipment shown. As each additional load was added, the new position of a marker along a metre rule was recorded and the extension calculated.



The investigation was repeated with an additional identical spring, arranged as shown.



For a given applied load, which of the following statements is correct?

☐ **A** The extension is doubled because the spring constant is doubled.

☐ **B** The extension is doubled because the spring constant is halved.

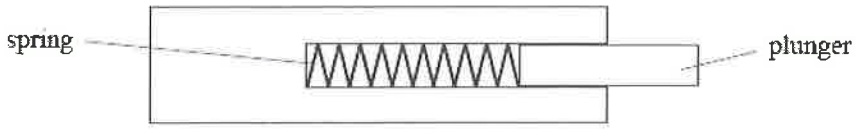
(1)

☒ **C** The extension is halved because the spring constant is doubled.

☐ **D** The extension is halved because the spring constant is halved.

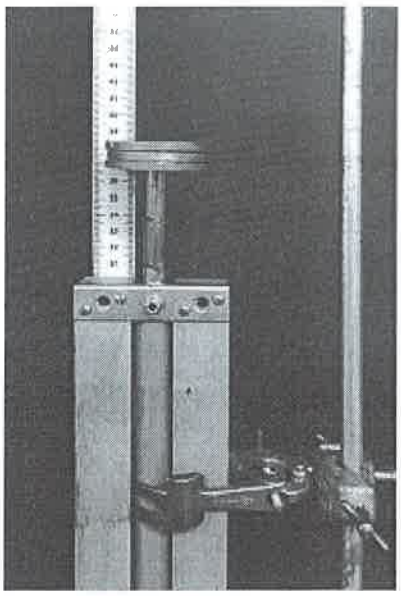
Section B

11. A school dynamics trolley has a plunger attached to a spring. When the plunger is pushed in, the spring is compressed. When the plunger is released, it is pushed back out by the spring.



(a) A student investigated the spring to determine whether it obeys Hooke's law in compression.

The trolley was placed vertically in front of a scale and weights were added in turn to the top of the plunger, as shown. The position of the end of the plunger was recorded each time.



The recorded results are shown in the table.

Weight / N	Position of plunger / cm	Δx / cm
0.00	37.3	0
2.00	37.0	0·3
4.00	36.6	0·7
6.00	36.2	1·1
8.00	35.9	1·4
10.00	35.5	1·8

(1) for all values of Δx correct

(i) Use the results to plot a graph of weight on the y-axis against compression on the x-axis *(this is the **change in length**, like the extension, but it's getting shorter, so we call it compression instead of having a negative value)*. You may use the additional column for your processed data.

(5)

Plot the graph on the graph paper on the LAST page of this paper. You may remove it to plot the graph, but make sure you get it stapled back in (as the last page).

This question continues on the next page.

(ii) The student concluded that the spring obeys Hooke's law with a spring constant of about 600 N m^{-1}.

Determine whether the student's conclusion is justified.

(4)

The line of best fit is a straight line through the origin (1), so the spring obeys Hooke's law because the extension is proportional to the force. (1)

Spring constant = gradient = $\frac{10N}{0.018m}$ (1) = $555.5 Nm^{-1}$

Values must be from big △ on line

$556 Nm^{-1}$ = $600 Nm^{-1}$ to 1 significant figure, so the student is correct. (1)

(Total for question = 9 marks)

12. Some spiders form silk in long, thin threads to catch flying insects.

The Darwin's bark spider can produce very long threads. A scientist investigated the properties of these threads.

The scientist applied forces to stretch threads of spider silk.

(a) The stress in one thread was 4.3 MPa. The radius of the thread was 1.9×10^{-6} m.

Calculate the force applied to the thread.

(3)

$\sigma = \frac{F}{A}$ $A = \pi r^2 = \pi (1.9 \times 10^{-6})^2 = 1.134 \times 10^{-11} m^2$ (1)

$4.3 \times 10^6 = \frac{F}{1.134 \times 10^{-11}}$ (1)

$F = 4.3 \times 10^6 \times 1.134 \times 10^{-11} = 4.87669 \times 10^{-5} N$

Force = $4.88 \times 10^{-5} N$ (1)

(b) The scientist investigated a thread of length 25.0 m.

Determine the length of this thread when stretched to its limit of proportionality.
Young modulus of spider silk = 8.70 GPa
stress at limit of proportionality = 300 MPa

(4)

$E = \frac{\sigma}{\varepsilon}$ $8.7 \times 10^9 = \frac{300 \times 10^6}{\varepsilon}$ (1)

$\varepsilon = \frac{300 \times 10^6}{8.7 \times 10^9} = 0.03448$

$\varepsilon = \frac{\Delta x}{x}$ $0.03448 = \frac{\Delta x}{25}$ (1)

$\Delta x = 0.03448 \times 25 = 0.86207$

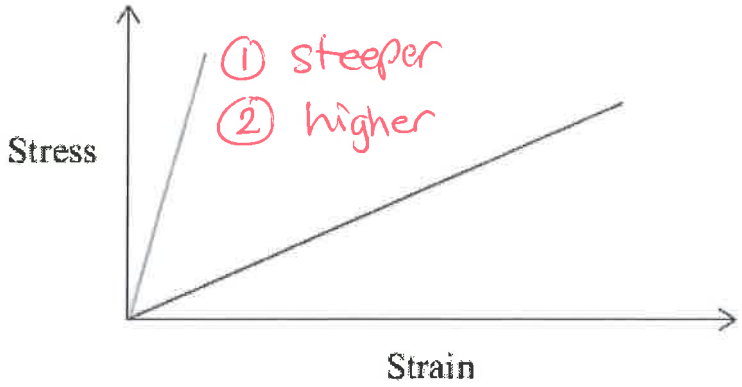
Total new length $= x + \Delta x = 25 + 0.86 = 25.86 m$ (1)

Length at limit of proportionality = $25.86 m$ (1)

(c) The table shows some properties of spider silk and a type of steel.

Material	Young modulus / GPa	Stress at limit of proportionality / MPa
Spider silk	8.70	300
Steel	200	350

(i) The sketch graph shows the stress-strain relationship for the spider silk up to its limit of proportionality.



Add a line to the sketch graph to show the stress-strain relationship for the steel up to its limit of proportionality.

(2)

(Total for question = 9 marks)

13. A crane supports a load of 950 N with a steel cable. If the breaking stress of steel is 500MPa, calculate the smallest **diameter** cable that can be used.

(3)

$\sigma = \frac{F}{A}$ $500 \times 10^6 = \frac{950}{A}$ (1)

$A = \frac{950}{500 \times 10^6} = 1.9 \times 10^{-6} m^2$

$A = \pi r^2$ $1.9 \times 10^{-6} = \pi r^2$ (1)

$r = \sqrt{\frac{1.9 \times 10^{-6}}{\pi}} = \sqrt{6.048 \times 10^{-7}} = 7.777 \times 10^{-4} m$

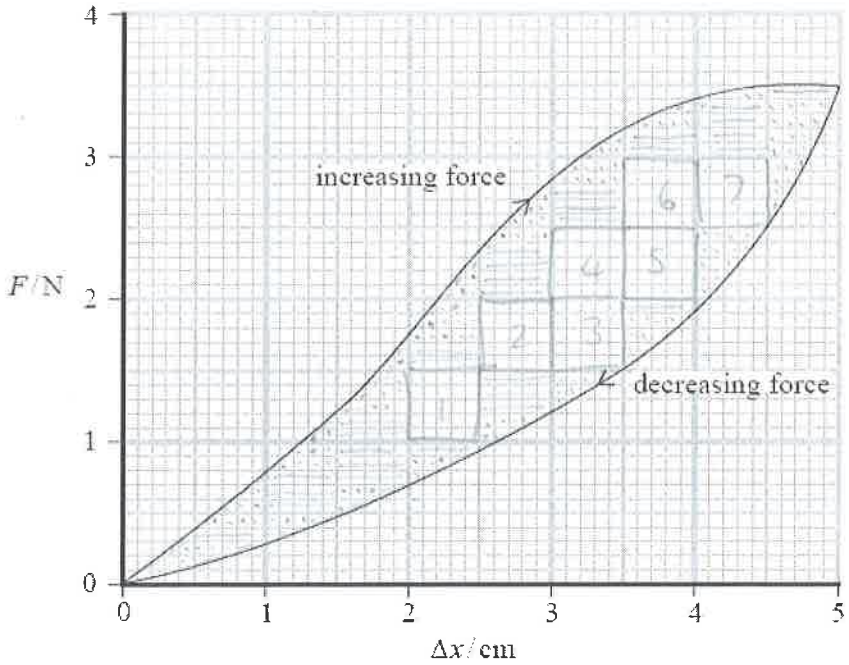
diameter $= 2r = 2 \times 7.777 \times 10^{-4} = 1.5554 \times 10^{-3} m$

Smallest diameter of cable = 1.56 mm (1)

(Total for question = 3 marks)

14. A student applied a force F to a rubber band. The student measured the corresponding extension, Δx, as F was increased and then decreased.

The graph shows how Δx varied as F was increased and then decreased.



(a) State how the graph shows that the rubber band deformed elastically.

(1)

The extension is zero when the force was removed. (1)

(b) The work done on the rubber band as F increased is greater than the work done by the rubber band as F was decreased.

There is a difference in these values because heating occurred.

Determine the energy that caused heating as F was increased and then decreased to zero.

(3)

Difference

E_{EL} = area between the lines (1) since E_{EL} = area under the line (1)

Total 479 (1) little squares. Each little square 0.1×10^{-2} m, 0.1 N

$E_{EL} = 479 \times 0.1 \times 10^{-2} \times 0.1 = 0.0479$

or 19 big (5x5) squares or (1)

Energy that caused heating = 0.048 J (1)

(0.0425 → 0.053) J

(Total for question = 4 marks)

15. Under certain conditions, many materials obey Hooke's law.

(a) State Hooke's law and describe the conditions under which it is valid.

(2)

Hooke's law states that the extension is proportional to the force (1) if the limit of proportionality is not exceeded. (1)

(b) Describe the behaviour of a spring when it is stretched beyond the region where Hooke's law is obeyed.

MAX (2) OF THESE ---

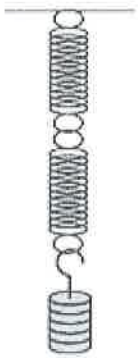
(2)

There will be a greater extension for the same increase in force, (1) so it is no longer true that extension is proportional to the force. (1)

If the spring is stretched beyond the elastic limit, (1) it will remain permanently deformed and not return to its original length. (1)

(Total for question = 4 marks)

16. A student investigated the behaviour of a spring. Another student repeated the investigation using two new springs connected in series as shown.



The springs were identical to the spring used in the original investigation.
Explain why the spring constant for this arrangement of the springs would be half that for one spring.

(4)

Each spring has the same force exerted (1) on it, so each spring extends by the same amount as a single spring would. (1)

Therefore, for the same force, the total extension is doubled. (1)

$F = k\Delta x$ so $k = \frac{F}{\Delta x}$ so if Δx doubles and F is constant, k will be half the original spring constant. (1) MUST REFER TO THE EQUATION

(Total for question = 9 marks)

17. A student carried out an experiment to determine the Young modulus of constantan.
The student had a constantan wire with cross-sectional area A of 3.97×10^{-7} m^2.
The unstretched length x of the wire was 4.00 m.

(a) The student had enough slotted masses to apply a weight of up to 150 N to the wire.

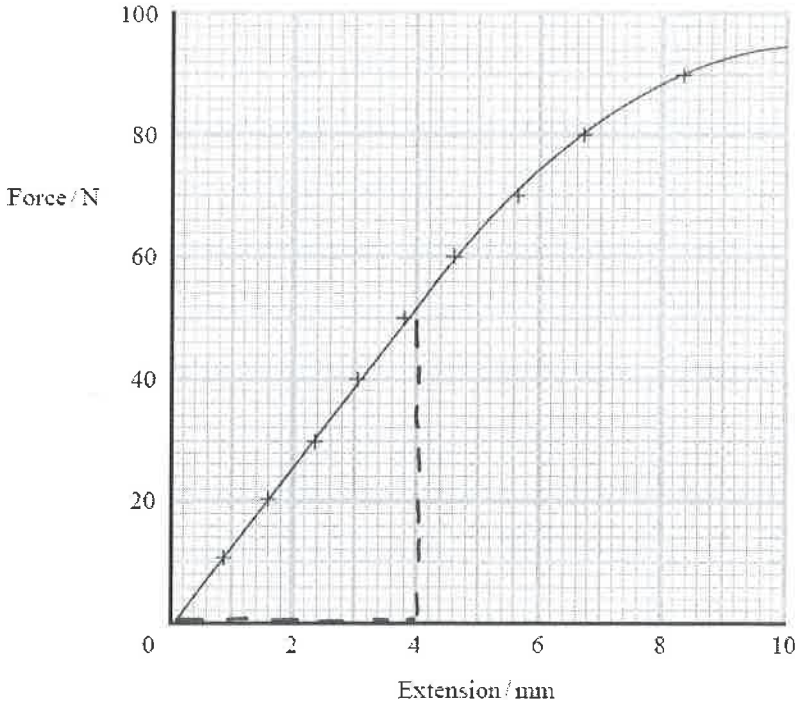
The breaking stress for constantan is about 420 MPa.
Deduce whether the wire could support a weight of 150 N.

(3)

$\sigma = \frac{F}{A} = \frac{150}{3.97 \times 10^{-7}}$ (1) $= 377.8 \times 10^6$ Pa

$\sigma = 380$ MPa (1) which is less than the breaking stress of 420 MPa, so the wire will not break. (1)

(b) The student added slotted masses to the wire and determined the corresponding extensions. The student plotted a graph of force against extension, as shown.



(i) Show that the stiffness of the wire is about 1.3×10^4 N m^{-1}.

(2)

Stiffness = gradient = $\frac{52}{4\times10^{-3}}$ N m^{-1} (1) = 1.30×10^4 N m^{-1} (1)

Gradient must be from straight line

Must have 3 s.f.

(ii) The relationship between the stiffness k of the wire and the Young modulus E is given by

$$k = \frac{EA}{x}$$

where x is the unstretched length of the wire (4m) and A is the cross-sectional area of the wire (3.97×10^{-7} m^2).
Determine a value for the Young modulus of constantan using the student's data.

(2)

$1.3\times10^4 = \frac{E\,(3.97\times10^{-7})}{4}$ (1)

$E = \frac{4\times1.3\times10^4}{3.97\times10^{-7}} = 1.3098\times10^{11}$

(1)

Young modulus = 131 GPa

Or use own value from b(i)

(Total for question = 7 marks)

Graph paper for Q11

