

1(a). Two students are investigating springs and forces.  
They begin by comparing **three** different springs.

They measured how much each spring stretched for a range of different weights attached.

Here are their results:

SPRING A	
Force (N)	Extension (cm)
0.0	0.0
1.0	0.7
2.0	1.4
3.0	2.1
4.0	2.8
5.0	3.5

SPRING B	
Force (N)	Extension (cm)
0.0	0.0
1.0	0.6
2.0	1.0
3.0	1.6
4.0	2.4
5.0	3.8

SPRING C	
Force (N)	Extension (cm)
0.0	0.0
1.0	1.6
2.0	3.2
3.0	4.8
4.0	6.4
5.0	8.0

One of the students makes a comment about the data.



The data for all of the springs follow a linear relationship.

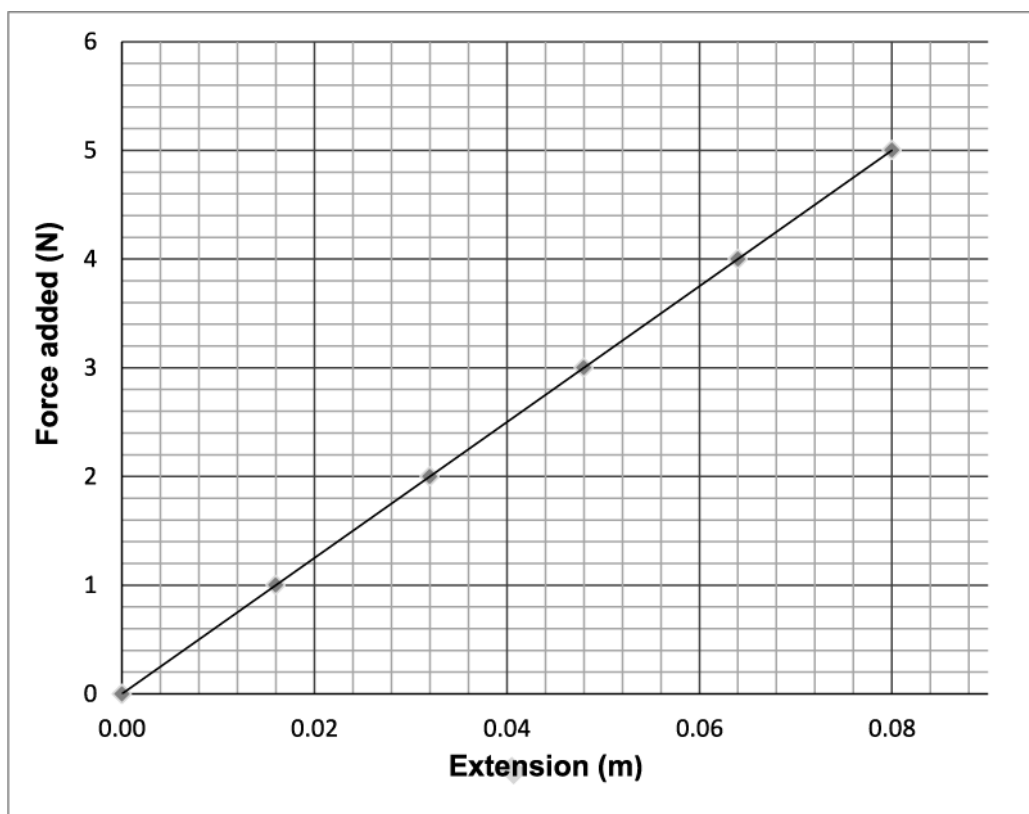
Is this student correct?

Use your understanding of what is meant by a linear relationship to help explain your answer.

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[2]

(b). They then plotted a graph of the data for **spring C**. (Note that the extension of the spring is in metres).



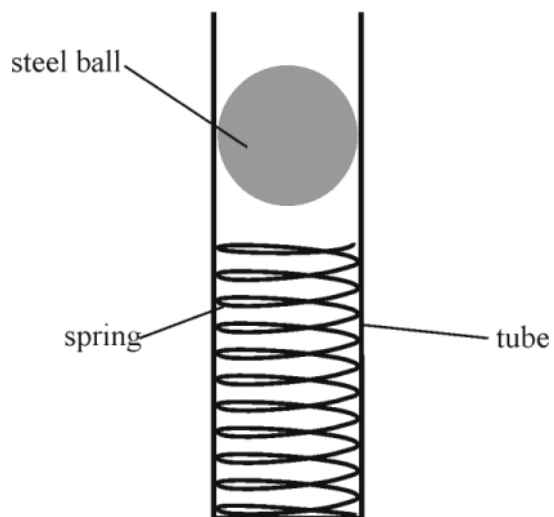
Use the graph to calculate the amount of work done (in joules) in stretching the spring over the first 8 cm (0.08 m).

----- J [2]

(c). When a rubber band is pulled, it stretches quite easily to start with and then becomes stiffer. Sketch a curve on the graph above to show this behaviour.

[1]

2. This question is about using a spring to fire a small steel ball from a 'cannon'.  
The spring fits inside a tube, as shown below.



The spring is compressed, and the energy stored in the spring is used to fire the ball.

The spring used has a spring constant of  $32 \text{ N/m}$ , and the steel ball has a weight of  $0.14 \text{ N}$ .

The ball is placed on top of the spring. Show that the weight of the ball compresses the spring by about  $4 \text{ mm}$ .

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[3]

END OF QUESTION PAPER

### Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
1	a	<p>(The student is incorrect / partly correct)</p> <p>Springs A and C follow a linear relationship / spring B does not follow a linear relationship (1)</p> <p>In a linear relationship the extension increases in equal amounts (as the force does) / the graph is a straight line from the origin (1)</p>	2	marks are for the <b>explanation</b>
	b	<p>Area under graph OR <math>0.5 \times 5 \times 0.08</math> (1)</p> <p>0.2 (J) (1)</p>	2	
	c	Curve line drawn starting 0,0 parabola-like curve with increasing gradient.	1	
		<b>Total</b>	<b>5</b>	
2		<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b></p> <p>If answer = 0.0044 m <math>\approx</math> 4 mm award 3 marks</p> <p>Recall and rearrange <math>F = kx \Rightarrow x = F \div k</math> (1)</p> <p>= 0.14 m <math>\div</math> 32 N/m (1)</p> <p>= 0.0044 m <math>\approx</math> 4 mm (1)</p>	3	1st mark can be for algebraic rearrangement or for direct substitution and arithmetical rearrangement <b>do not allow</b> 4 mm without evaluation shown to more precision.
		<b>Total</b>	<b>3</b>	