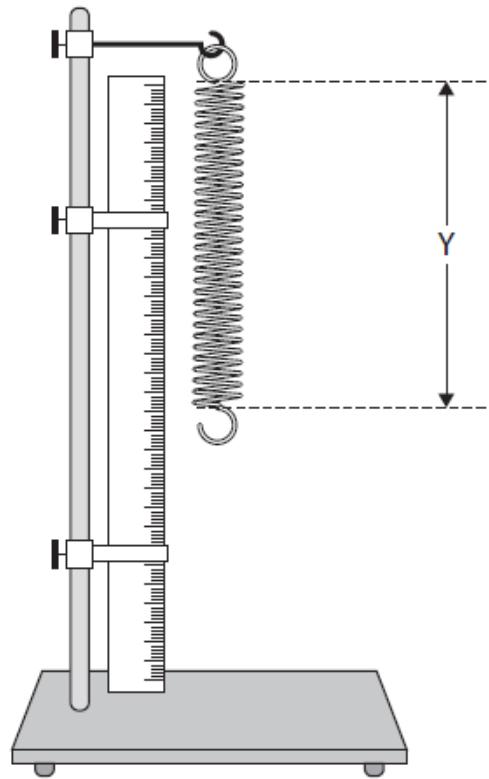
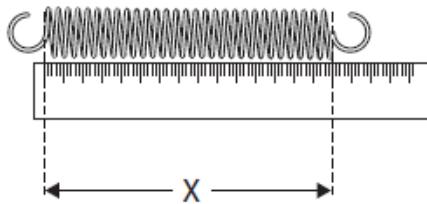


## Questions

Q1.

**Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).**

A student measures the length of a spring when it is horizontal and when it is vertical, as shown in Figures 15a and 15b.



**Figure 15a**

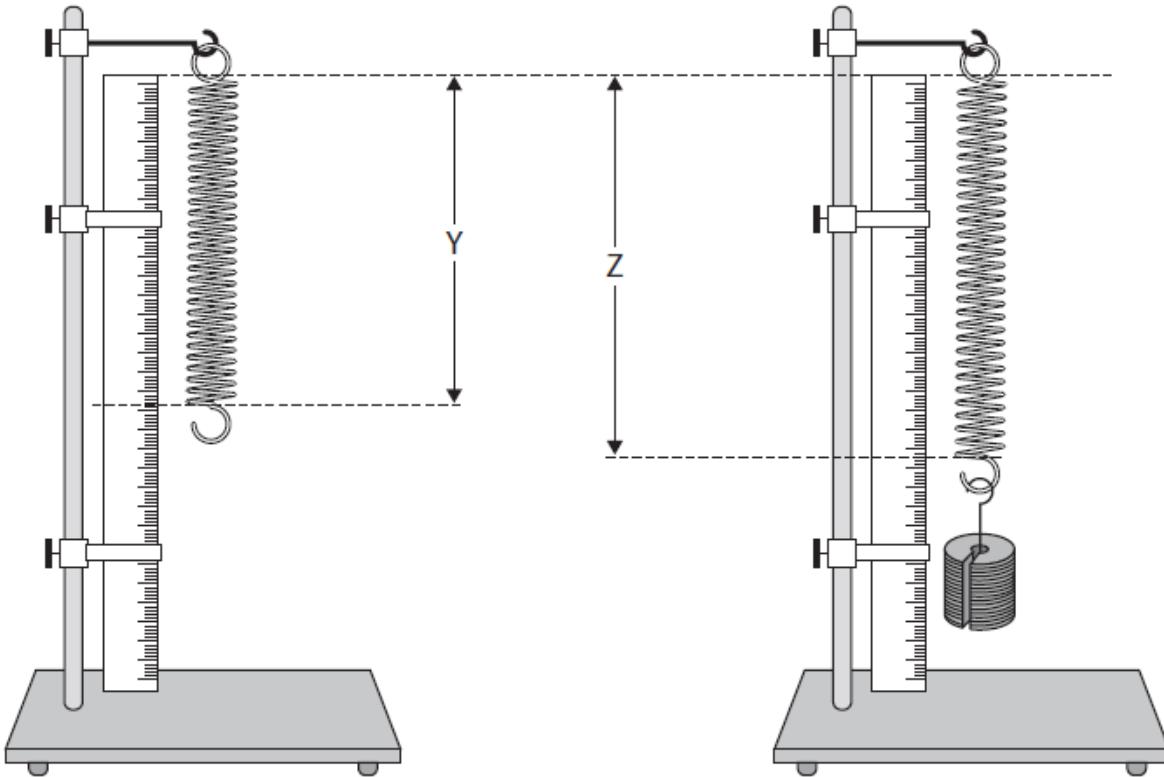
**Figure 15b**

The length, Y, of the vertical spring in Figure 15b is greater than the length, X, of the spring in Figure 15a.

- (i) Give a reason why the length of the spring in Figure 15b is greater than the length of the spring in Figure 15a.

(1)

- .....  
.....  
(ii) The student adds some weights to the end of the spring, as shown in Figure 16b.



**Figure 16a**

**Figure 16b**

(Source: <https://www.shalom-education.com/courses/ks3-physics/lessons/motion-and-forces/topic/deformation-and-hooke-s-law/>)

The extension of the spring due to these added weights is equal to

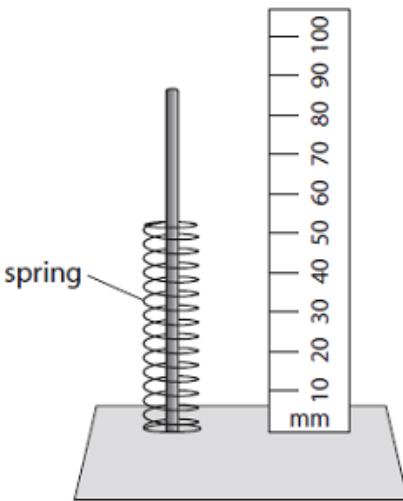
(1)

- A**  $Z - Y$
- B**  $Z + Y$
- C**  $Z$
- D**  $Y$

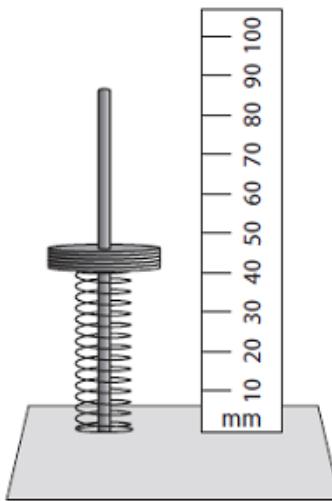
**(Total for question = 2 marks)**

Q2.

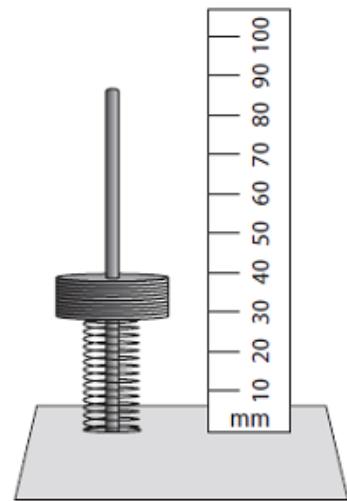
Figure 14 shows a spring standing on a table.



**Figure 14a**



**Figure 14b**



**Figure 14c**

Weights are added to the spring as shown in Figures 14b and 14c.

- (i) Estimate the original length of the spring as shown in Figure 14a.

(1)

$$\text{original length} = \dots \text{mm}$$

- (ii) Describe how the reduction in the length of the spring when weights are added can be determined.

(2)

.....

.....

.....

.....

- (iii) State **two** ways that the experimental procedure could be improved.

(2)

1 .....

.....

2 .....

.....

- (iv) Give **one** reason why the reduction in length eventually reaches a limit as more weights are added.

(1)

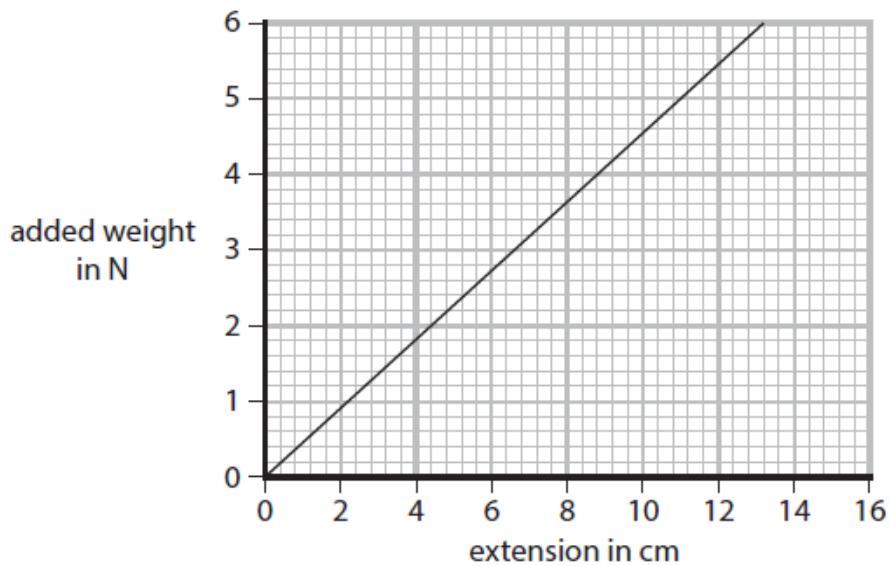
.....

**(Total for question = 6 marks)**

Q3.

The extension of the spring in Figure 16b is now determined for different weights added to the spring up to a maximum of 6 N.

Figure 17 shows a graph of the results.



**Figure 17**

(i) The increase in potential energy stored in the spring is equal to the area under the graph in Figure 17.

Calculate the increase in potential energy stored in the spring when the spring is extended from 0 cm to 8 cm.

Give your answer in joules (J).

(3)

energy = ..... J

(ii) Calculate the spring constant of the spring using data from the graph in Figure 17.

State the unit.

(2)

spring constant = ..... unit

.....  
(iii) The box in Figure 18 represents a weight added to the end of the spring.



**Figure 18**

Draw **two** vectors on Figure 18 to complete a free body force diagram of a 5 N weight in equilibrium.

(2)

**(Total for question = 7 marks)**

Q4.

Another spring is extended.

The work done to extend the spring is 0.14 J.

The spring constant of the spring is 175 N/m.

Calculate the extension of the spring.

Use an equation selected from the list of equations at the end of this paper.

(3)

extension of spring = ..... m

**(Total for question = 3 marks)**

Q5.

A spring is extended.

A force of 0.50 N gives an extension of 13 mm.

Calculate the spring constant  $k$  in N/m.

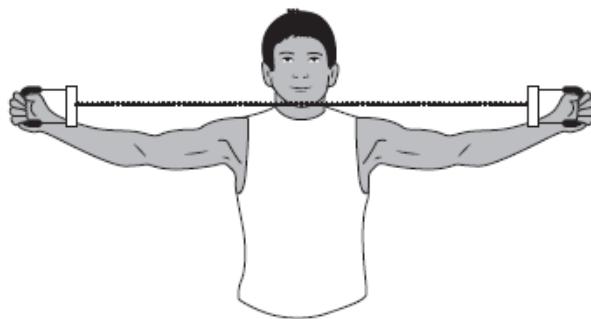
**(3)**

spring constant  $k$  = ..... N/m

**(Total for question = 3 marks)**

Q6.

Figure 14 shows an athlete using a fitness device.



**Figure 14**

The athlete stretches the spring in the device by pulling the handles apart.

The spring constant of the spring is 140 N/m.

The athlete does 45 J of work to extend the spring.

The athlete takes 0.6 s to expand the spring.

(i) Calculate the useful power output of the athlete when stretching the spring.

(2)

useful power output of the athlete = ..... W

(ii) Calculate the extension of the spring.

Use an equation selected from the list of equations at the end of this paper.

(3)

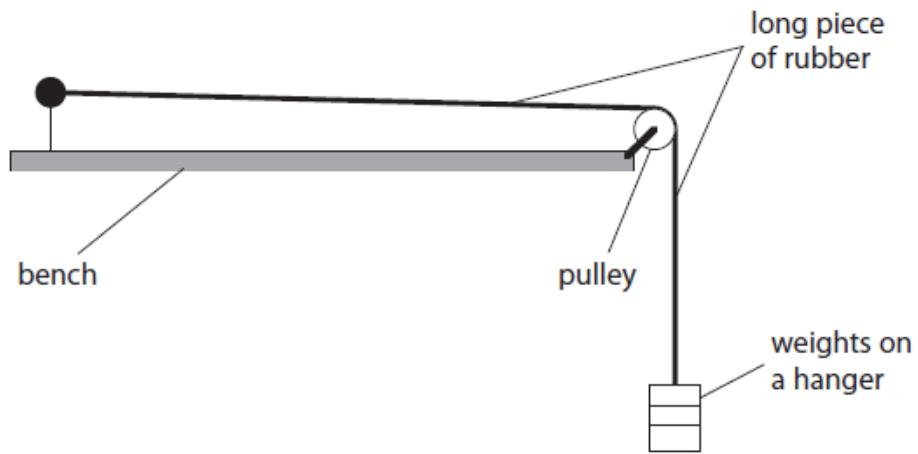
extension of the spring = ..... m

**(Total for question = 5 marks)**

Q7.

A student investigates the stretching of a long piece of rubber.

Figure 15 shows the apparatus to be used.



**Figure 15**

The student puts just enough weight on the weight hanger to make the piece of rubber just tight.

The student wants to plot a graph to show how the extension of the piece of rubber varies with the force used to stretch it.

The student adds a known weight to the weight hanger.

(i) Describe how the student could measure the extension of the rubber when he adds another weight to the weight hanger.

(2)

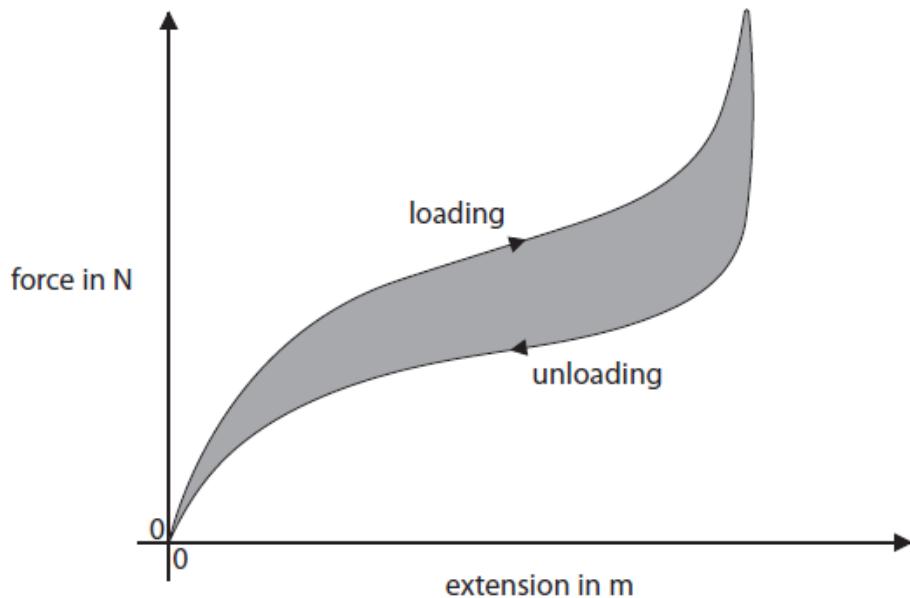
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- (ii) The student obtains a series of values of force and extension while loading the piece of rubber and then unloading it.

Figure 16 shows the graph of the student's values.



**Figure 16**

Explain how the shape of this graph shows that the distortion of the piece of rubber being stretched is different from the distortion of a spring being stretched.

(2)

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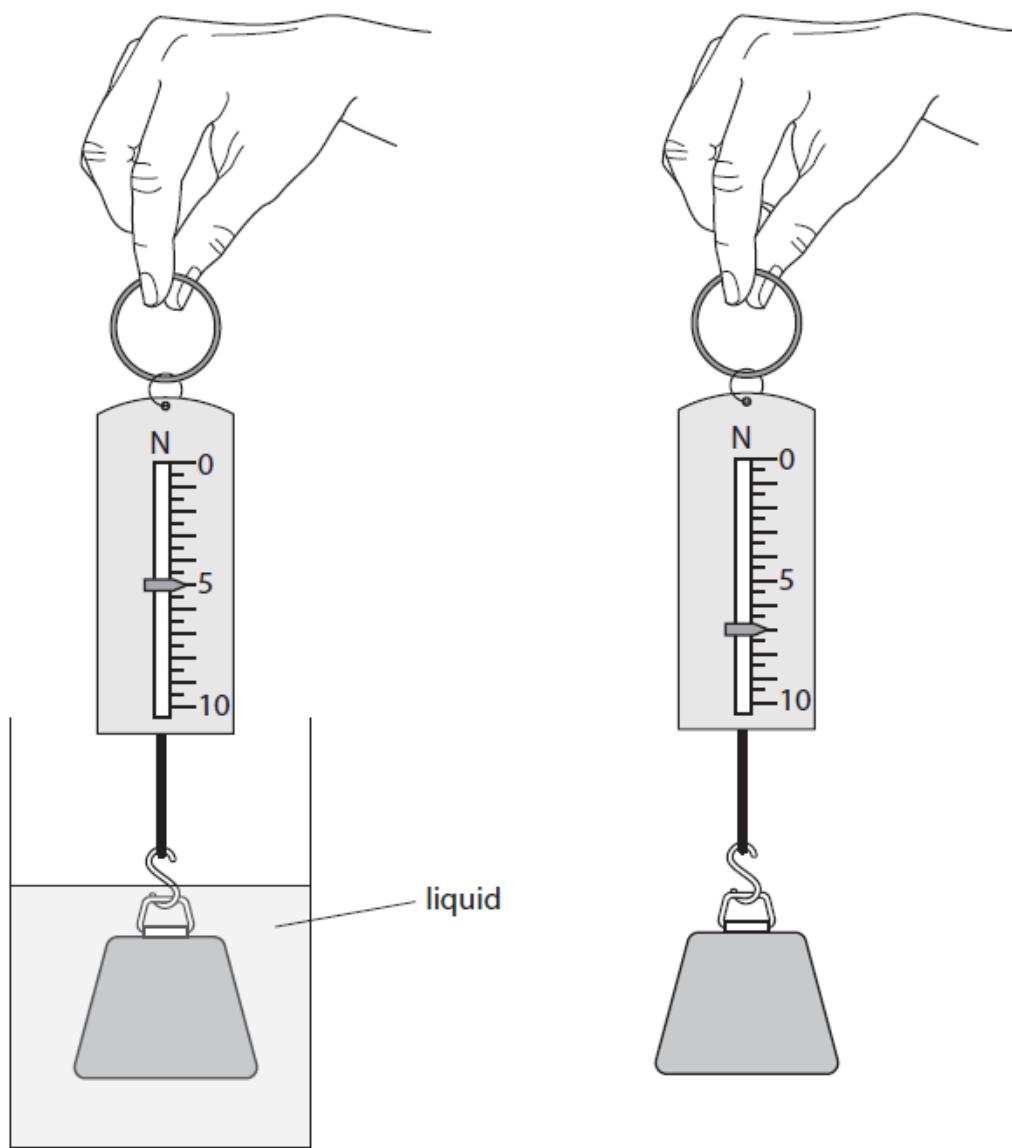
**(Total for question = 4 marks)**

Q8.

Figure 20 shows a metal block being weighed by a newton meter (force meter).

In Figure 20a the block is hanging in a liquid.

In Figure 20b the **same** block is hanging in air.



**Figure 20a**

**Figure 20b**

- (i) Explain why the reading on the newton meter is different in Figures 20a and 20b.

(2)

- (ii) The density of the liquid is  $1.4 \times 10^3 \text{ kg/m}^3$ .

Calculate the density of the block.

Gravitational field strength,  $g$ , = 10 N/kg

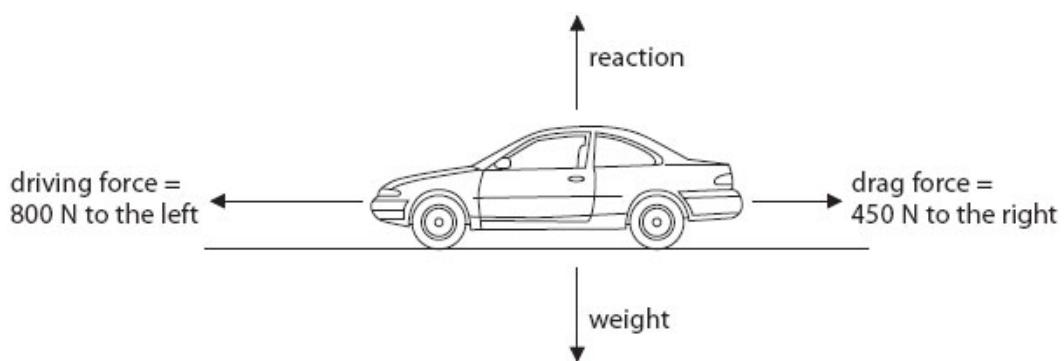
(4)

density = ..... kg/m<sup>3</sup>

**(Total for question = 6 marks)**

Q9.

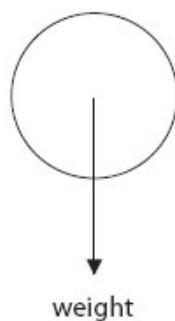
The diagram shows the forces acting on a car which is travelling along a flat straight road.



Forces also act on objects when they fall through the air.

There are two forces acting on this ball as it falls through the air.

The weight is shown on the diagram.



(i) Draw and label an arrow on the diagram to show the other force acting on the ball.

(2)

(ii) Use words from the box to complete the sentences.

(2)

balanced    changing    greater    smaller    zero

After a short time the ball falls at a steady speed.

The forces acting on the ball are now .....

The acceleration of the ball is now .....

## **Mark Scheme**

Q1.

<b>Question number</b>	<b>Answer</b>	<b>Additional guidance</b>	<b>Mark</b>
<b>(i)</b>	(force of) gravity / weight (acts on spring)		<b>(1) AO2</b>

<b>Question number</b>	<b>Answer</b>	<b>Additional guidance</b>	<b>Mark</b>
<b>(ii)</b>	<b>A</b> Z-Y  B is incorrect because it is a sum not a difference of the two lengths C is incorrect because that is the final length of the spring D is incorrect because that is the initial length of the spring		<b>(1) AO1</b>

Q2.

<b>Question number</b>	<b>Answer</b>	<b>Additional guidance</b>	<b>Mark</b>
<b>(i)</b>	50.0 to 55.0 (mm) inclusive		<b>(1)</b>

<b>Question number</b>	<b>Answer</b>	<b>Additional guidance</b>	<b>Mark</b>
(ii)	a description including note the original length (1)  note the final length and subtract (1)		(2)

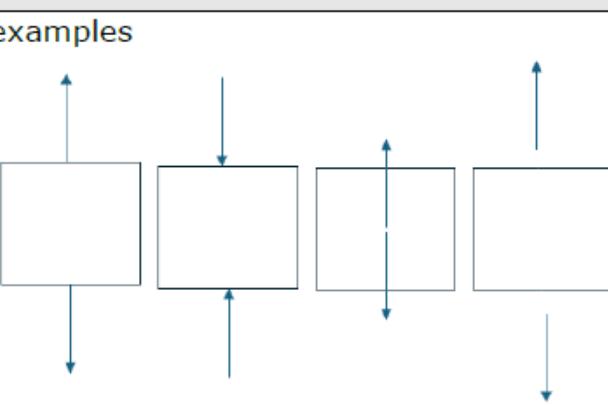
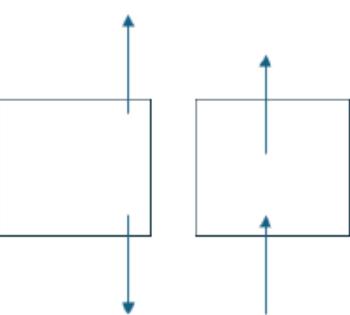
<b>Question number</b>	<b>Answer</b>	<b>Additional guidance</b>	<b>Mark</b>
(iii)	any two from:  use a ruler with a smaller/millimetre divisions (1)  use interim values of weight (1)  add more weights ( to increase the range) (1)  move the ruler closer to the spring (1)  use of pointer (1)  repeat <b>and</b> average (1)	ignore more accurate  add fixed values of weights  eye level / no parallax	(2)

<b>Question number</b>	<b>Answer</b>	<b>Additional guidance</b>	<b>Mark</b>
(iv)	the coils are {pushed together /touching} (1)  or  spring is fully compressed /cannot be made shorter (1)		(1)

Q3.

Question number	Answer	Additional guidance	Mark
(i)	relevant values from graph(1) $8 (\times 10^{-2})$ and 3.6 seen substitution (1) (energy = ) $0.5 \times 3.6 \times 8 (\times 10^{-2})$ evaluation (1) (energy = ) 0.14 (J)	accept 8 ( $\times 10^{-2}$ ) and values between 3.6 and 3.7  accept value between 0.14 and 0.15 (J) values between 0.14 and 0.15 (J) to any other power of ten scores 2 marks values between 0.28 and 0.30 (J) scores 2 marks values between 0.28 and 0.30 (J) to any other power of ten scores 1 mark award full marks for correct answer without working	(3) AO2

Question number	Answer	Additional guidance	Mark
(ii)	45 or 0.45 (1) <b>OR</b> 45 N/m or 0.45 N/cm (2)	allow values between 44 and 47 or between 0.44 and 0.47  allow full marks for values between 44 and 47 N/m or between 0.44 and 0.47 N/cm	(2) AO2

Question number	Answer	Additional guidance	Mark
(iii)	<p>two straight vertical arrows in opposite directions and (if extended) go through centre of the box (judge by eye) (1)</p> <p>label 5N on both arrows (1)</p>	<p>examples</p>  <p>scores this mark</p>  <p>does not score this mark</p> <p>independent mark</p>	<p>(2) AO1</p>

Q4.

<b>Question number</b>	<b>Answer</b>	<b>Additional guidance</b>	<b>Mark</b>
	<p>substitution (1)  <math>0.14 = \frac{1}{2} \times 175 \times x^2</math></p> <p>rearrangement for <math>x^2</math> (1)</p> <p><math>(x^2 =) \frac{0.14 \times 2}{175}</math> or <math>\frac{0.14}{0.5 \times 175}</math></p> <p>evaluation (1)  <math>0.04</math> (m)</p>	<p>substitution and rearrangement in either order</p> <p><math>x^2 = \frac{E}{\frac{1}{2} \times k}</math></p> <p><math>1.6 \times 10^{-3}</math> seen gains 2 marks  <math>0.02(m)</math> gains 2 marks  <math>0.028</math> gains 1 mark</p> <p>award full marks for the correct answer without working</p>	<b>(3)</b>

Q5.

<b>Question number</b>	<b>Answer</b>	<b>Additional guidance</b>	<b>Mark</b>
	<p>recall and substitution (1)  <math>0.5 = k \times 13 (\times 10^{-3})</math></p> <p>rearrangement (1)</p> <p><math>\frac{0.5}{13(\times 10^{-3})}</math></p> <p>evaluation (1)  <math>38</math> (N/m)</p>	<p><math>k = \frac{F}{x}</math></p> <p>allow <math>38.5</math> (N/m) or <math>38.46</math> (N/m) or <math>39</math> (N/m)</p> <p><math>0.04/0.038</math> (N/m) gains 2 marks</p> <p><math>2958</math> (N/m) gains 1 mark (<math>x^2</math> used in equation)</p> <p>award full marks for the correct answer without working</p>	<b>(3)</b>

Q6.

Question Number	Answer	Additional guidance	Mark
(i)	<p>recall (1)  <math>P = \frac{E}{t}</math></p> <p>substitution and evaluation (1)  <math>P = 75</math> (W)</p>	$P = \text{work done} \div \text{time}$ $P = \frac{45}{0.6}$  award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>substitution into <math>E = \frac{1}{2} \times k \times x^2</math> (1)</p> $45 = \frac{1}{2} \times 140 \times x^2$  <p>rearrangement (1)</p> $(x =) \sqrt{\frac{2 \times 45}{140}}$  <p>evaluation (1)</p> $0.8(0)$ (m)	allow substitution and rearrangement in either order $x^2 = (\frac{E}{0.5k}) \frac{2 \times 45}{140}$ $x^2 = 0.64(28571)$  accept values that round to 0.80 e.g. 0.80178  award full marks for the correct answer without working	(3)

## Q7.

Question Number	Answer	Additional guidance	Mark
(i)	<p>A description including any one from the following (1)</p> <p><b>measure</b> a length or a specific distance related to the rubber or weights on a hanger      OR      with a <b>named device</b> (e.g. metre rule / stick / ruler / measuring tape)      OR      note position of a fixed point on rubber / weight carrier</p> <p><b>AND</b></p> <p>extension calculated / measured as the change in or difference between two positions or lengths or extensions (1)</p>	<p>evidence may be taken from additions to the diagram</p> <p>ignore vague statements such as see how it much it extends</p>	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation linking graph of rubber band is non-linear / curved / not directly proportional (1)</p> <p>graph for unloading does not go through same points as loading (1)</p>	<p>(graph for) spring would be straight</p> <p>(graph for) spring would only have one line / go through the same points</p> <p>ignore reference to returning to original shape / length</p>	(2)

## Q8.

Question number	Answer	Additional guidance	Mark
(i)	<p>an explanation linking            (apparent) loss in weight of block in liquid(1)</p> <p>(equal to) weight of liquid displaced            (1)</p>	<p>upthrust            /buoyant force            on block</p> <p>liquid more            dense than air</p>	(2) <b>AO1</b>

Question number	Answer	Additional guidance	Mark
(ii)	<p>calculation of weight lost (1)            2 (N)</p> <p>attempt to determine volume of block (1)  <math>(V = ) \frac{2 (\times 10^{-1})}{1.4 (\times 10^3)}</math></p> <p>or  <math>(V = ) \frac{5 (\times 10^{-1})}{1.4 (\times 10^3)}</math></p> <p>or            3.6 (<math>\times 10^{-4}</math>)            (weight of 5 N used)</p> <p>substitution to determine density of block (1)  <math>(\rho = ) \frac{7 (\times 10^{-1})}{1.43 (\times 10^{-4})}</math></p> <p>evaluation (1)  <math>(\rho = ) 4900 \text{ (kg/m}^3\text{)}</math></p>	<p>accept (7 – 5)            accept 0.2 (kg)</p> <p>accept  <math>(V = ) \frac{2 (\times 10^{-1})}{1.4 (\times 10^3)}</math></p> <p>or  <math>(V = ) \frac{5 (\times 10^{-1})}{1.4 (\times 10^3)}</math></p> <p>or            3.6 (<math>\times 10^{-4}</math>)            (weight of 5 N used)</p> <p>accept  <math>\underline{7 (\times 10^{-1})}</math>            3.6 (<math>\times 10^{-4}</math>)</p> <p>accept values that round to 4900            e.g. 4895</p> <p>4900 to any other power of ten scores 3 marks (incorrect unit conversion)</p> <p>1960 scores 3 marks            1960 to any other power of ten scores 2 marks            (used wrong weight of liquid)</p> <p>100 000 scores 3 marks            100 000 to any other power of ten scores 2 marks</p>	(4) <b>AO2</b>

	(wrong rearrangement)  250 000 scores 2 marks 250 000 to any other power of ten scores 1 mark (used wrong weight of liquid and wrong rearrangement)  award full marks for the correct answer without working	
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Q9.

	<b>Answer</b>	<b>Acceptable answers</b>	<b>Mark</b>
(i)	  air resistance (1)	upward arrow on any part of line  (1) vertical line from any point on the diagram  air friction, upthrust, drag Ignore any downward arrow labelled weight or gravity	(2)
(ii)	Balanced (1)  Zero (1)		(2)