Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			Apply a force to the piston ✓	1 (AO 1.2)	**IGNORE** increase the pressure / decrease the volume / syringe **ALLOW** heat the gas **ALLOW** push / move the (moveable) piston (in) **DO NOT ALLOW** pull / move out piston (CON) **Examiner's Comments** This question was well answered.
			Total	**1**	
2			D	1 (AO 2.2)	**Examiner's Comments** This question was very well answered with almost all the candidates realising that the elastic band would only stretch in D.
			Total	**1**	
3			A	1 (AO 2.1)	**Examiner's Comments** This question was answered well. Where errors were made it was invariably giving option B, i.e. candidates incorrectly rearranging the quantities from the equation sheet. High-scoring candidates often used the white space to write down the equation they used, before rearranging it and calculating the answer.
			Total	**1**	
4	a		**First check the answer on answer line** **If answer = 0.56 (J) award 2 marks** ($W = ½ kx^2$) $W = ½ \times 28 \times 0.20^2$ ✓ W = 0.56 (J) ✓	2 (AO 2.1) (AO 2.1)	**IGNORE** $28 \times 0.20 = 5.6$ and 1.12 **Examiner's Comments** Candidates found this question

					challenging, with many choosing the incorrect equation of F = kx giving an answer of 5.6 J. It is good practice to select the correct equation and substitute the numbers from the question, before evaluating the response.
	b	i	Incorrect <u>and</u> Force is not proportional to extension ✓	1 (AO 1.2)	**ALLOW** line is not straight (through the origin) / not linear / gradient not constant / is a curve **IGNORE** faster / slower etc. **<u>Examiner's Comments</u>** A large minority of candidates gained credit in this question. Some candidates thought that the statement was correct because the elastic band returned to its original shape. Candidates who gained the credit either stated that the forces was not proportional to the extension or that the lines were not straight.
		ii	Incorrect <u>and</u> It returns to its original length / shape (when force is removed) ✓	1 (AO 1.2)	**ALLOW** it returns to (an extension of) zero **<u>Examiner's Comments</u>** More candidates gained credit in this question. Some candidates gave vague responses, although it was expected that candidates would refer to the original length or shape of the elastic band.
		iii	Incorrect <u>and</u> Line is not straight (through the origin) / line does not have constant gradient / line is a curve ✓	1 (AO 1.2)	**ALLOW** force is not proportional to extension **IGNORE** not linear **IGNORE** faster / slower etc. **<u>Examiner's Comments</u>** The majority of candidates gained credit. Some low scoring candidates effectively repeated the 'incorrect' by stating as their reason that the graph was non-linear.
			Total	**5**	
5			**C**	1 (AO 1.1)	**<u>Examiner's Comments</u>** The majority of candidates gained

					credit. Common incorrect responses were B and D.
			Total	**1**	
6			**D**	1 (AO 2.1)	**Examiner's Comments** Many candidates found this question challenging. A good technique observed by some candidates was adding distances from the pivot for the 30 N force. Some candidates used the white space surrounding the question effectively, writing down the anticlockwise moment and the total of the clockwise moments. A common incorrect response was B, where candidates had used 40 cm rather than 60 cm as the perpendicular distance.
			Total	**1**	
7			**D**	1 (AO 1.1)	**Examiner's Comments** The majority of candidates gained credit although a significant number of candidates chose B or C.
			Total	**1**	
8			**C**	1 (AO 2.1)	**ALLOW** 0.060 (m) **Examiner's Comments** This question required candidates to identify the relevant equation from the equation sheet and rearrange it to determine the extension of the spring. The majority of candidates wrote down their calculations next to the question and were able to manipulate the equation correctly to find the extension. Some common errors seen included choosing the wrong equation, incorrectly rearranging the equation, or calculating $(\text{extension})^2$ but forgetting find the square root of this number.
			Total	**1**	

9			C ✓	1 (AO2.1)	**Examiner's Comments** This question required candidates to take account of the squared relationship between energy stored in the spring and the extension of the spring. A number of candidates chose option B.
			Total	**1**	
10	a		R **and** As it requires the least force or weight to compress it (by a metre) / lowest spring constants✓	1 (AO3.2b)	No mark if S or T chosen **ALLOW** less stiff **Examiner's Comments** Most candidates gained marks linking the answer of R with the lowest spring constant. Some candidates identified R as the spring but then repeated the question by stating that R compresses the most. Some lower scoring candidates stated T since it had the largest spring constant.
	b	i	**Any one from:** extensions / readings are close to the smallest measurement the ruler can make / AW ✓ rulers can only measure to the nearest mm ✓	1 (AO3.3a)	**ALLOW** extensions / readings are very small ✓ **ALLOW** difficult to measure extensions accurately with a ruler ✓ **Examiner's Comments** When answering this type of question candidates need to give answers that are relevant to the experiment and the data given. In this experiment the extensions are very small and close to each other and most importantly close to the smallest division (1 mm) on a ruler.
		ii	Use a larger mass / weight / force (to increase the extension) ✓	1 (AO3.3b)	**ALLOW** bigger for larger (BOD) **ALLOW** use springs with smaller spring constants **Examiner's Comments** Candidates needed to explain a method to obtain larger extensions. The majority of candidates correctly suggested the use of a larger weight.

	c	i	Correct point identified / point at 4 springs ✓ Correct new point plotted at (4, 0.6) ✓	2 (AO3.2a) (AO1.2)	**Examiner's Comments** This question was answered well with most candidates correctly circling the incorrectly plotted point. Some candidates did not then plot it in the correct position.
		ii	As number of springs increases, extension decreases ✓ **or** extension is inversely proportional to the number of springs ✓ ✓	2 (2 × AO3.1a)	**ALLOW** As the number of springs doubles, the extension halves ✓ ✓ **Examiner's Comments** Most candidates correctly stated that as the number of springs in parallel increased, the extension decreases. A small minority of candidates went on to state that the extension is inversely proportional to the number of springs in parallel. **Assessment for learning** Understand how to test inverse proportionality both from tables of data and from graphs Candidates should be given the opportunity to check whether two quantities are inversely proportional. For example, when considering the variation of pressure p in a fixed mass of gas at constant temperature with the volume V (a) If one quantity is doubled the other quantity is halved, e.g. if the pressure is double the volume is halved. (b) By multiplying pairs of the two quantities together to see whether a constant is produced, e.g. pV = constant (c) From a graph taking pairs of quantities and applying (a) or (b) (d) Plotting a graph of one of the quantities against the inverse of the other quantity, e.g. plot a graph of p

					against $1/V$ – if a straight line is produced that passed through the origin, then p is inversely proportional to V.
	d		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 50 award 5 marks** Correct reading from the graph of 1.6 cm ✓ Correct conversion to 0.016 m ✓ Spring constant = force / extension ✓ 0.8 / 0.016 ✓ 50 (N / m) ✓	5 (AO2.2) (AO1.2) (AO1.2) (AO2.2) (AO2.2)	**ALLOW ECF** 0.012 m for reading 1.2 cm from graph Correct rearrangement of equation **ECF** 0.8 / 0.012 **ALLOW** 4 marks for 0.5 or 5 or any other power of ten error **ALLOW ECF** 4 marks for 67 **ECF ALLOW** 3 marks for 0.67 or 6.7 or any other power of ten error **Examiner's Comments** Many candidates did not score well on this question since they did not give full answers Exemplar 2  The candidate has identified the read off from the graph (1.6 cm) and converted it to 0.016 m. The candidate has correctly rearranged the equation and then substituted the data before evaluating the answer. **Assessment for learning** Candidates should show their working in calculations. Candidates should: (a) Write the equation they are to use (b) Rearrange the equation so that the unknown quantity is the subject of the equation (c) Substitute the data into the equation (d) Evaluate the data showing intermediate stages (e) Give the answer

					(f) Consider the number of significant figures This method will also assist candidates in checking their answers.
			Total	**12**	
11			B ✓	1 (AO1.1)	**Examiner's Comments** Most candidates realised that P was linear, but a small minority of these candidates then incorrectly thought that Q was elastic.
			Total	**1**	
12			B ✓	1 (AO2.1)	**Examiner's Comments** A small number of candidates multiplied the force of 150 N by 30.7 cm rather than 30.0 cm.
			Total	**1**	
13			C ✓	1 (AO2.1)	**Examiner's Comments** Candidates should be encouraged to use the white space around the question to demonstrate their working. The sensible method in this question is to use the equation to work out the pressure in the liquid then use the equation a second time to work out the force. A number of candidates incorrectly gave the answer as A.
			Total	**1**	
14			B ✓	1 (AO2.1)	**Examiner's Comments** In this question a small minority of candidates calculated the potential energy for one step. Candidates who scored a mark on this question often underlined the data used in the question.
			Total	**1**	