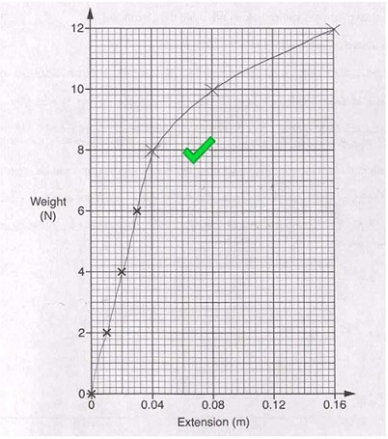
Mark scheme – Forces in Action (H)

Question			Answer/Indicative content	Marks	Guidance
1			B	1 (AO2.1)	**Examiner's Comments** This was the first calculation on the paper and about 80% gave the correct answer B. A common incorrect response was 'A', presumably due to confusion over clockwise and anticlockwise.
			Total	**1**	
2			A ✓	1 (AO2.1)	**Examiner's Comments** In this calculation about a third of candidates gave the correct answer A. The other distractors were randomly selected.
			Total	**1**	
3			B ✓	1 (AO1.1)	**Examiner's Comments** Most candidates understood that a moment is required to cause a rotation.
			Total	**1**	
4			A ✓	1 (AO2.1)	**Examiner's Comments** This question was generally answered well. Candidates should be encouraged to consider the units. In the units in each answer is given as N / kg, then 16 N should be divided by 10 kg giving an answer of 1.6 N / kg.
			Total	**1**	
5			C ✓	1 (AO2.1)	**Examiner's Comments** The majority of candidates realised that the mass (× *g*) × distance above the ground was needed. For this type of question, it is good to calculate the potential energy for each option.
			Total	**1**	
6			A ✓	1 (AO1.1)	**Examiner's Comments** This question was generally answered well. For the cogs shown since the reverse must

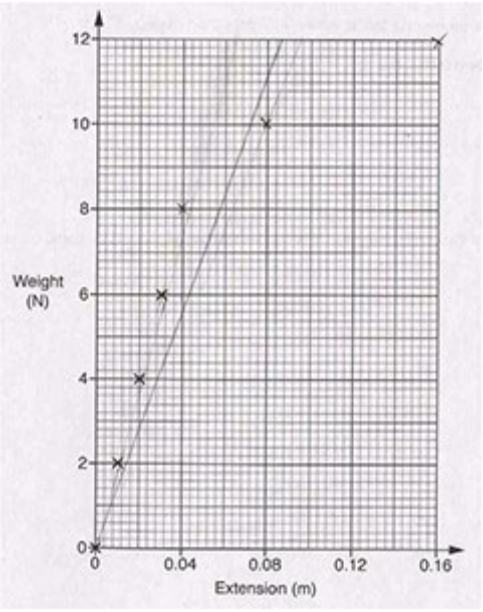
					also be true, response A was straightforward. Candidates who did not gain this mark often chose response B.
			Total	**1**	
7			A ✓	1 (AO2.1)	**Examiner's Comments** This was well answered by higher ability candidates. Often the half or the change of unit (cm to m) was missing. Higher ability candidates wrote the equation from the data sheet, then substituted the numbers into the equation and then carried out the calculation.
			Total	**1**	
8			D	1 (AO2.1)	
			Total	**1**	
9			B	1 (AO1.2)	
			Total	**1**	
10			A	1 (AO2.1)	
			Total	**1**	
11			B	1	
			Total	**1**	
12			C	1	
			Total	**1**	
13			D	1	
			Total	**1**	
14			A	1	
			Total	**1**	
15			Rod **attracts** water ✓ • Opposite charges attract ✓ • water has both + and − charges / idea of polarisation / AW ✓	3 (AO3 × 1.2)	**IGNORE** positive electrons / movement of protons / ions for this answer. **ALLOW** Water bends or moves towards rod **OR** for candidates that have misinterpreted the diagram as repulsion of water then **ALLOW**

					Rod **repels** water / water bends or moves away from rod ✓ • Like charges repel ✓ • water has both + and − charges / idea of polarisation / AW ✓ **Examiner's Comments** The diagram was interpreted differently by candidates. Some thought it attracted (ideal scenario) and others thought it repelled. However marks were made available for both lines of thought as both interpretations were valid from the diagram. It gave a full range of marks and discriminated well with about 10% gaining full marks by including the idea of polarisation. The ideas of repulsion of water and opposite charges repelling were credited 2 marks.
			Total	**3**	
16	a	i	All three points correctly plotted ✓✓ **OR** two points correctly plotted ✓	2 (AO 2 × 2.2)	Points should be + / − ½ square or less (by eye) **Examiner's Comments** All the points were usually plotted correctly.
		ii	straight line up to 0.04, 8 **and** curved line consistent with points plotted past this point ✓	1 (AO 3.1a)	**ALLOW ecf from part ai for misplotted points** **ALLOW** straight part of graph drawn without ruler. **DO NOT ALLOW** dot-to-dot for curve **Single** line should be **thin** (less than ½ square thick) and **continuous** to gain the mark. **Examiner's Comments** Just over half of answers gained the one mark here. Common mistakes were double lines, lines too thick (larger than half a square) and straight line of best fit with no curve. Exemplar 1



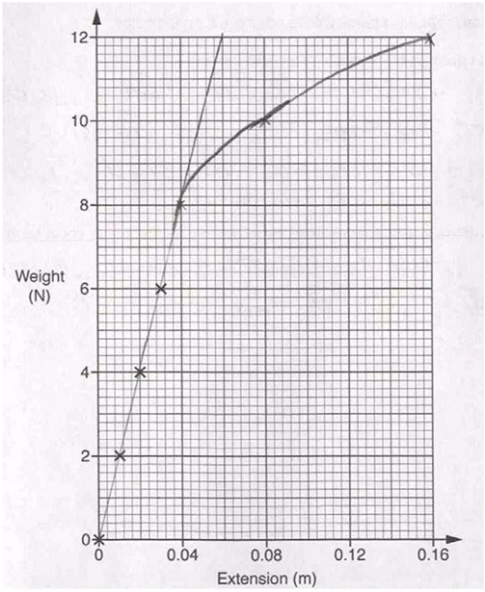
This gets full marks for both parts as the answer shows accurate plotting for part i of the question and produces a straight line graph in part ii that becomes curved after 8N. Although the line does slightly miss the point at 8N, the line and curve are reasonable.

Exemplar 2

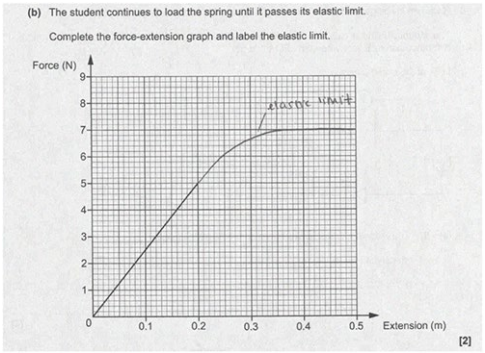


This was a common error with points plotted accurately but a straight line drawn so this was credited 0 marks.

Exemplar 3

					 This shows two lines, one curved and one straight. The marker cannot give credit as they are unsure which one to mark. In any case the curved line would have been too thick to award the mark as it is thicker than half a square.
		iii	Initially the **extension** increases steadily / linearly / uniformly / (directly) proportionally / elastically / AW ✓ (then the) wire reaches its **elastic limit** ✓ the extension increases plastically / by more for each (2N) weight added (past this point) / AW ✓	3 (AO 3.1a) (AO 1.2) (AO 3.1a)	**ALLOW** gradient is steady up to 8N **ALLOW** initially obeys Hooke's law **IGNORE** limit of proportionality (as this is an AO3 answer for an AO1 question) **ALLOW** Hooke's law not obeyed after 8N **Examiner's Comments** This gave a good range of marks with most describing the first stage as extension is linear or proportional. Some clearly referred to elastic limit [1 mark] although vague answers such as 'limit of proportionality' was frequently seen [0 mark]. Some were successful in describing the extension after the limit is reached.
	b		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 200 (N/m) award 3 marks** k = F ÷ x ✓ k = 6 ÷ 0.03 ✓ (or equivalent correct expression from 0 to 6N) k = 200 (N/m) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**IGNORE** F=kx Substitution into correctly rearranged formula ✓✓ **Examiner's Comments** This calculation, like many on the paper was answered well. Here about third quarters of

					answers gained all three marks. For unsuccessful calculations however, 1 mark was given for the correct rearrangement of the formula k = F ÷ x.
	c		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.16 (J) award 2 marks** E = 0.5 × 200 × 0.04^2 ✓ E = 0.16 (J) ✓	2 (AO 1.2) (AO 2.1)	**ALLOW** ecf from part b **ALLOW** area under graph method: 0.5 × 8 × 0.04 ✓ **BUT** area under graph method used to calculate 0.16 scores ✓✓ **Examiner's Comments** Most candidates incorrectly used 'work done = force × distance' giving the answer 0.32 (J). Better answers used E = 0.5 × 200 × 0.4^2 to successfully get 0.16 (J) and gained full marks.
			Total	**11**	
17	a		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 25 (N/m) award 3 marks** Recall and rearrange: spring constant = force exerted by a spring ÷ extension ✓ = 5 ÷ 0.2 ✓ = 25 (N/m) ✓	3 (AO1.2) (AO2.1) (AO2.1)	**ALLOW** any other correct pair of points from the graph – points to be read to ±½ a small square Final answer between 24 and 26 (N/m) scores three marks **Examiner's Comments** The majority of candidates scored highly on this question. Higher ability candidates stated either the equation for spring constant or stated that the spring constant was the gradient of the graph. It was then expected that candidates would substitute into their equation appropriate values from the graph. A small but significant minority of candidates tried to use the same equation from the data sheet which had been used to determine the energy transferred and substituted in a force

					for the energy. This approach was not creditworthy. **AfL** Candidates should be able to read information from graphs and determine a gradient.
	b		Line curves and gradient decreases ✓ Point at the end of the linear section of the line labelled 'elastic limit' ✓	2 (AO2x 1.2)	**IGNORE** poorly drawn curves/thick lines **DO NOT ALLOW** curve with negative gradient at any point **Examiner's Comments** This question required candidates to demonstrate that they understood how a spring stretched with an increasing force and the term "elastic limit". For marks to be given the straight line section (if any) should be drawn with a ruler and the curve should be smooth. Sometimes the labelling of the elastic limit was vague. Higher ability candidates added a small cross at the elastic limit and then labelled the cross. **Exemplar 2**  This candidate has clearly extended a straight line and then drawn a curve with decreasing gradient which gains the first mark. The labelling of the elastic limit is vague and incorrect. It would have been helpful if this candidate had indicated precisely on the line with a dot or cross where the elastic limit is located and then added a label.
	c			3 (AO3x 2.2)	**DO NOT ALLOW** labels pointing to apparatus

			A downwards arrow labelled weight/load ✓ An upwards arrow labelled tension ✓ <u>Two</u> equal length arrows (by eye), one vertically up and one vertically down ✓		**ALLOW** gravity/gravitational force **DO NOT ALLOW** mass **ALLOW** force from spring **NOTE** this mark may not be scored if more than two arrows are drawn **<u>Examiner's Comments</u>** A small majority of candidates gained at least two marks for this question. Most of these candidates drew two arrows of equal length and labelled correctly the weight or gravitational force. Few candidates labelled the upwards arrow "tension" or "force from spring". A common misconception was the use of the term "upthrust". When representing vectors by straight lines, candidates should be encouraged to use a ruler with a millimetre scale. Ideally candidates should refer to the gravitational force as "weight" or "force due to gravity" rather than "gravity". A few candidates did not understand a "free body force diagram" and drew the apparatus and labelled the apparatus. Other errors were the drawing of many arrows on the diagram in varying directions. **Exemplar 3**  This candidate has drawn a "free body force diagram" with two arrows of the same length – the candidate confirms that the arrows are the same length. Force of load was allowed for one of the label marks.
			Total	**8**	
18			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1260 or 1300 (Nm) award 4 marks** (Force = 70 x 10 =) 700 (N) ✓ (Moment =) force x distance ✓ (Moment =) 700 x 1.8 ✓ (Moment =) 1260 (Nm) ✓	4 (AO2.1) (AO1.2) (AO2.1) (AO2.1)	**ALLOW** ecf for using mass not weight e.g. 3 marks for an answer of 126 (Nm), 2 marks for 70 x 1.8 **ALLOW** ecf for incorrect calculation of force **ALLOW** ecf for converting 1.8m to 180cm e.g. 3 marks for 126 000 (Nm)
			Total	**4**	