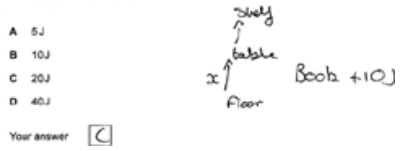
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			Mistake 1: (gravitational fields cause) repulsion ✓ Correct word 1: (gravitational fields cause) attraction ✓ Mistake 2: (More massive objects have a) smaller (gravitational field strength)✓ Correct word 2: (More massive objects have a) greater (gravitational field strength) / **AW**✓ OR Mistake 2: More (massive objects have a smaller gravitational field strength) ✓ Correct word 2: Less (massive objects have a smaller gravitational field strength) ✓	4 (AO 3.2a) (AO 1.1) (AO 3.2a) (AO 1.1)	Mistakes can be listed in any order **ALLOW** smaller = less massive **Examiner's Comments** Some candidates wrote out the whole of the statements containing a mistake and the whole of a corrected statement with the mistake corrected. Others just wrote the incorrect words and the correct replacements. The question proved to be accessible to candidates across the grade range. Although many of the less successful candidates correctly identified 'repulsion' in the second statement as incorrect, the correction of 'attraction' was less often seen from these candidates.
			Total	**4**	
2	a	i	90° (to the side of the bottle)	1 (AO 1.2)	**ALLOW** perpendicular/at right angles/horizontally **Examiner's Comments** Question 21 (a) (i) was answered correctly by all but the least successful candidates.
		ii	Pressure causes a net force at right angles to any surface/ **AW** ✓	1 (AO 1.1)	**Examiner's Comments** Very few candidates were able to answer this question correctly.
	b	i	**First check the answer on the answer line** **If answer = 15 (Pa) award 3 marks** P = F / A ✓ P = 1.8 / 0.12 ✓ P = 15 ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**Examiner's Comments** Most higher and medium performing candidates were able to answer this correctly. Candidates who wrote down the formula and correctly substituted into it were credited for this. A few candidates mistakenly squared the 0.12 m^2 as part of their calculation.

		ii	doubles ✓	1 (AO 3.1b)	**ALLOW** 2 x their answer to (b)(i) (e.g., 30) **IGNORE** increases **Examiner's Comments** Question 21 (b) (ii) was generally well answered.
			Total	**6**	
3			**Level 3 (5–6 marks)** Detailed description of the trend shown **AND** detailed suggestions to obtain more accurate or precise results. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Clear description of the trend shown **and** clear suggestions to obtain more accurate or precise results **OR** Detailed description of the trend shown **and** simple suggestions to obtain more accurate or precise results. **OR** Basic description of the trend shown **and** detailed suggestions to obtain more accurate or precise results *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Basic description of the trend shown. **OR** Simple suggestions to obtain more accurate or precise results. *The information is basic and communicated in an unstructured*	6 (AO 3.1a x 3) (AO 3.3b x 3)	**AO3.1a Analyses the results to interpret the trend shown by the graph.** For example • as the load increases, acceleration increases / as the load decreases, acceleration decreases • double the force you double the acceleration • Spots anomaly (3.12 vs 3.0) • 4x force gives 4x acceleration • the relationship is (approximately) linear /(directly) proportional (e.g., approx. 1.5m/s^2 increase per 2kg, 0.75m/s^2 per kg) • use of m = F/a / Newton's second law **AO3.3b Analyses the information to improve experimental procedures.** For example • Repeat readings (take a mean) • Take more readings (3 readings is not enough)/extend range / more (different) loads • Record acceleration data to a consistent number of decimal places/significant figures • Adjust the ramp height to eliminate friction • Use the full length of the ramp • Use a shorter piece of string/raise the table height/move ramp to the left to stop the load hitting the floor

			way. The information is supported by limited evidence and the relationship to the evidence may not be clear. **0 mark** *No response or no response worthy of credit.*		• Ensure the total of the trolley mass and mass of the load are the same throughout. • Weighing the load each time • Make sure start at **exactly** same point • Closer intervals between loads **<u>Examiner's Comments</u>** Question 22 was a relatively straightforward Level of Response question for most Foundation tier candidates, and many were able to give a creditworthy response. In common with Level of Response questions from the past, there were two parts to the question. In this case, a trend and suggestions for improving accuracy. Many candidates chose to focus on just one of the parts, which restricted their overall level. There were good examples of high-level responses to both parts of the question, but only rarely were these seen together on the same script. Exemplar 3  • From the results we can see that when the load increases, so does the acceleration. It is a directly proportional relationship between the load and the acceleration. • In order to obtain more accurate and precise results we may need to use more than three loads. • This will mean that many trends lines will be easier to see with more results. • They also need to repeat the experiment multiple times with different loads not just once in order to make the experiment more precise. • They could also make the loads go up more frequently rather than 2, 4, 6 g (could have 1, 2, 3, 4, 5). • Finally you could have more precise values as the experiment. This will ensure that we have the most accurate and precise results. In Exemplar 3, the candidate gives a clear trend when they state that when the load (on the weight hanger) increases, so does the acceleration, and that this is a directly proportional relationship. The candidate goes on to suggest several improvements which will increase accuracy and precision in a clear and logically structured way. This response is at Level 3 and was

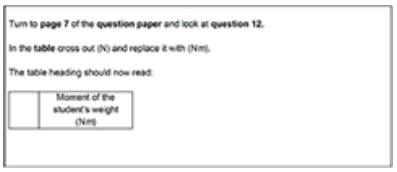
					given 5 marks, rather than 6 as some information relevant to this level is not presented and substantiated.
			Total	**6**	
4			B	1 (AO 1.1)	
			Total	**1**	
5			B	1 (AO 2.1)	**Examiner's Comments** Many successful candidates used the 'white space' to lay out the conversion and the calculation. The correct answer was B, but many chose D as they did not convert the 40 cm to 0.4 m.
			Total	**1**	
6			C	1 (AO 2.1)	**Examiner's Comments** The majority of candidates correctly answered C. Most candidates who did not gain credit answered B, which corresponds to the increase in gravitational potential energy for a distance *x* from the table to the shelf, but not the **total** increase in gravitational potential energy from the floor to the shelf. Candidates should be encouraged to underline the key words. As shown in the exemplar below, a quick sketch/diagram is helpful in questions like this. Exemplar 1  In this response, the candidate has used the white space around the question to help interpret the question. The diagram has assisted in understanding what is meant by 10 J as well as indicating the change in moving the book from the floor to the shelf.

			Total	**1**	
7	a	i	P ✓	1 (AO 1.2)	**ALLOW** A to B
		ii	P ✓	1 (AO 1.2)	**ALLOW** A to B
		iii	B ✓	1 (AO 1.2)	
		iv	Q ✓	1 (AO 1.2)	**ALLOW** B to C **Examiner's Comments** Question 19a was generally poorly answered by all but the highest performing candidates. Many who did not get part (i) correct were able to answer part (ii) correctly.
	b		2 ✓	1 (AO 1.1)	**Examiner's Comments** Higher performing candidates answered this correctly, but a common misunderstanding of the question was to miss the word 'number' and answer in terms of a force, for example '1N'
	c	i	**First check the answer on answer line** **If answer = 4.2 (N) award 2 marks** (F =) 28 x 0.15 ✓ (F =) 4.2 (N) ✓	2 (AO 2.1) (AO 2.1)	
		ii	**First check the answer on answer line** **If answer = 0.315 (J) award 2 marks** (E =) 0.5 x 28 x 0.15^2 ✓ (E =) 0.315 (J) ✓	2 (AO 2.1) (AO 2.1)	**ALLOW** 0.32 (J) **Examiner's Comments** Question 19 (c) was two simple calculations where all candidates had to do was substitute in to equations from the equation sheet and most middle and higher performing candidates managed full marks on both parts. Many lower performing candidates were also given full marks on part (i). On part (ii) less successful candidates substituted in to the elastic potential energy equation but did not square the extension, so those who had written the numbers into the

					equation as working were given 1 mark that was missed by candidates who had just written the incorrect answer.
			Total	**9**	
8		i	Moves clockwise / student B goes down / student A goes up ✓ More turning force/moment on the right-hand side / student B provides more turning force/moment ✓	2 (AO 1.2) (AO 2.2)	**ALLOW** down on the right / up on the left **ALLOW** heavier (student) goes down / lighter student goes up **ALLOW** student A is heavier than student B **AND** is sitting the same distance from the pivot. **Examiner's Comments** Many candidates across the range of performance were able to identify that Student B moved down, but only a handful of higher performing candidates explained that this was due to a higher **turning** force or moment. Many candidates said that Student B had a 'higher force', but this was insufficient to gain the second marking point. The simplicity of the situation in the diagram may have contributed to this. If the distance had been different each side, it would have been more obvious that the response needed to be in terms of a moment, however this would have made the first marking point harder to achieve for lower performing candidates.
		ii	**First check the answer on answer line** **If answer = 0.48 (m) award 3 marks** (LHS/anticlockwise moment = 400 × 0.6 =) 240 (Nm) / (RHS/clockwise moment =) 500 × d ✓ LHS moment = RHS moment / 240 = 500d ✓ (d=) 0.48 (m) ✓	3 (AO 2.1) (AO 2.1) (AO 2.1)	**ALLOW** 240 ÷ 500 = d ✓ **Examiner's Comments** Higher performing candidates were able to use the equation, but many did not first calculate Student A's moment before rearranging and substituting. This was quite a challenge for Foundation tier candidates and only the highest performing candidates were given full marks here.

			Total	**5**	
9			**B**	1 (AO 2.1)	ALLOW 3 **Examiner's Comments** More successful candidates often had evidence of working shown in the empty space to the right of this question.
			Total	**1**	
10			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1600 (J) award 3 marks** potential energy = mass × gravitational field strength × height ✓ (potential energy =) 80 × 10 × 2.0 ✓ (potential energy =) 1600 (J) ✓	3 (AO1.2) (2 × AO2.1)	**Examiner's Comments** Some candidates incorrectly converted 80 kg to 80,000 g. Other candidates omitted to include the gravitational field strength.
			Total	**3**	
11			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 750 (N) award 3 marks** Gravitational field strength / *g* = 10 (N/kg) ✓ 75 × 10 ✓ 750 (N) ✓	3 (AO1.1) (AO2.1) (AO2.1)	**ALLOW** 735 (N) as *g* = 9.8 has been used **ALLOW** *g* = 9.8 (N/kg) or 9.81 (N/kg) **ALLOW ECF** for maximum of 2 marks if incorrect value for *g* used **Examiner's Comments** **Assessment for learning** The specification requires that candidates should know that g = 10 N / kg.
			Total	**3**	
12	a		Mistake: Extension for 20 N recorded to different number of / only one significant figures ✓ Correction: Record all data to the same number of significant figures/decimal places ✓	2 (AO3.1a) (AO3.3b)	**ALLOW** different number of decimal places **ALLOW** specific corrections, e.g. 0.30 for both marking points **ALLOW** also any 2 s.f. measurement which rounds to 0.3 **Examiner's Comments**

					This part was well answered.
	b	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 67 (N/m) award 4 marks** (Spring constant =) force / extension ✓ 40 / 0.6 ✓ 66.7 (N/m) ✓ 67 (N/m) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	**ALLOW** *F / e* **ALLOW** Any two values correctly used from the table, e.g. 30÷0.45 / 20÷0.30 / 10÷0.15 **IGNORE** evaluation resulting from incorrect equation or incorrect substitution **ALLOW** 66.6/66.67/66.6 recurring for **3** marks **ALLOW** any previously calculated answer correctly rounded to 2 s.f. **Examiner's Comments** This calculation was well done, but many candidates lost a mark as they did not express the spring constant to two significant figures (often expressing it to two decimal places). **Assessment for learning** This calculation question requires the change of the subject of a formula. Some candidates find this difficult to do algebraically and might find it easier to write the equation in the form given, then substitute in the values, and then simplify that form to get the required variable by itself.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 12 (J) award 2 marks** $0.5 \times 67 \times (0.60)^2$ ✓ 12.(06) (J)✓	2 (AO2.1) (AO2.1)	**ALLOW** ECF from 22(b)(i) No evaluation mark unless substitution is correct **Examiner's Comments** More successful responses handled this calculation well. Less successful ones had a number of hurdles to leap: not converting the extension from m (as quoted) to cm, using their own value of spring constant and squaring the extension value. As a consequence many ended up with no marks here.

		iii	3 (.0) (m)	1 (AO3.1a)	ECF from (b)(i) value of *k* **ALLOW** extra precision e.g. 2.99 (m) **Examiner's Comments** More successful responses went back to the data table and scaled up the 20 N extension
	c		**Any two from**: Plastic deformation occurs ✓ Rope will not return to its original length/shape (when force is removed) ✓ Energy used/work done in making permanent changes to the rope ✓	2 (2 × AO1.1)	**ALLOW** Force and extension relationship is non-linear / no longer linear **Examiner's Comments** Very few candidates were given marks for this part. Most said the rope would snap, but more successful response realised that the rope would not return to its original shape and size.
			Total	**11**	
13			C ✓	1 (AO2.1)	**Examiner's Comments**  Turn to page 7 of the question paper and look at question 12. In the table cross out (N) and replace it with (Nm). The table heading should now read: Moment of the student's weight (Nm)
			Total	**1**	
14			B ✓	1 (AO1.1)	
			Total	**1**	