Mark scheme – Forces in Action (F)

Question			Answer/Indicative content	Marks	Guidance
1			**A** ✓	1 (AO1.1)	
			Total	**1**	
2			**C** ✓	1 (AO2.2)	
			Total	**1**	
3			**B** ✓	1 (AO1.1)	
			Total	**1**	
4			**C** ✓	1 (AO1.2)	**Examiner's Comments** Just over half of all candidates got this correct. The most common wrong answer here was D; candidates need to realise that 'elastic behaviour' for a spring is intended to refer to the straight-line section of the graph.
			Total	**1**	
5			**C** ✓	1 (AO2.1)	
			Total	**1**	
6			**B** ✓	1(AO2.2)	
			Total	**1**	
7			**C** ✓	1(AO2.1)	
			Total	**1**	
8			**B** ✓	1(AO1.1)	
			Total	**1**	
9			**B** ✓	1(AO1.1)	Option B was the correct answer. Option D was a common misconception, probably because the phrase 'see-saw' suggested rotation to many candidates. **Examiner's Comments**  **AfL** Rather than focus on a single word like 'see-

					saw' in the stem of a question, it can be helpful for candidates to try and visualise each of the operations described. At the pivot a see-saw does not move. The book is moving down in A and up in C. However the door is rotating on its hinges.
			Total	**1**	
10			**D** ✓	1 (AO2.1)	
			Total	**1**	
11			D	1 (AO1.1)	
			Total	**1**	
12			B	1 (AO2.1)	
			Total	**1**	
13			A	1 (AO2.1)	
			Total	**1**	
14			B	1	
			Total	**1**	
15			D	1	
			Total	**1**	
16			B	1	
			Total	**1**	
17			B	1	
			Total	**1**	
18			B	1	
			Total	**1**	
19	a		A (1) It is the steepest gradient (1)	2	
	b		It has passed its elastic limit **or** it no longer obeys Hooke's Law (1) (The spring is) permanently deformed / distorted **or** (the spring) has undergone plastic deformation (1)	2	
	c	i	$0.5 \times 27 \times (0.25^2)$ (1) 0.84 (J) (1)	2	**ALLOW** 0.25 (1) for conversion of cm to m.

		ii	Record the original length (1) Add a mass (1) Recorded the new length (1) Repeat for increasing masses (1)	4	
		iii	Any two from: Use smaller weights (1) Use a longer ruler (1) Clamp the clampstand to the bench so it will not topple (1)	2	
			Total	**12**	
20			B	1	
			Total	**1**	
21	a		Recall weight = mass × gravitational field strength (1) Substitute: 185 × 3.75 (1) 694 to 3 sig.figs (2) N (1)	5	**ALLOW** 693.75 (1) but no marks for significant figures
	b		'g' is greater on Earth than Mars / weight is bigger as 'g' is greater on Earth (1)	1	
			Total	**6**	
22	a	i	moment = force × distance ✓ clockwise moment = 800 (Nm) ✓ anti-clockwise moment = 1000 (Nm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	**ALLOW 2** marks (total) if clockwise and anti-clockwise moments are reversed Correct calculation of either moment implies correct equation so gets m.p.1 also **Examiner's Comments** Some candidates were confused as to the direction of rotation of 'clockwise' and 'anticlockwise', so credit was allowed to those who reversed their sense. Many candidates did not know how to calculate a moment, although this could be deduced from the units provided in the answer line (telling them to multiply the two). The unit Nm is the product of the force (N) and the distance (m) of each child from the pivot point of the seesaw.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.6 (m) award 3 marks** (anti-clockwise moment) 500 (N)×distance = 800 (N m) ✓	3 (AO1.2)	E.c.f. clockwise moment from (a)(i) for 800

			distance = 800 ÷ 500 ✓ = 1.6 (m) ✓	(AO2.2) (AO2.2)	(N m) If child B chosen, giving 1000 ÷ 400 = 2.5 (m), award 2 marks (loses m.p.1) **Examiner's Comments** Many candidates did not identify that the command word "calculate" was asking them to provide a mathematical solution rather than a qualitative descriptive of where child A should sit. Several candidates did calculate the correct answer and showed their workings in the space provided.
	b	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 100 (Pa) award 3 marks** pressure = force ÷ area ✓ = 10 ÷ 0.1 ✓ = 100 (Pa)✓	3 (AO1.2) (AO2.1) (AO2.1)	**Examiner's Comments** Many candidates were not able to recall the equation $P = F/A$. Some candidates did recall the equation and correctly calculated the pressure in the fluid as 100 Pa. A common misconception was using the equation $P = F \times A$ to calculate the pressure as 1 Pa.
		ii	at right angles/perpendicular/90° (to the plunger)	1 (AO1.1)	**ALLOW** to the left opposite to the force from the plunger **Examiner's Comments** Many answers here bore no relationship to the diagram: Any clear indication of direction including 'left' or 'at right angles' or 'perpendicular/90° to the plunger' were accepted. Ambiguous and inappropriate directions such as 'to the east' were not credited.
			Total	**10**	
23	a		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 120 (N/cm^2) award 3 marks** Recall: pressure = force ÷ area ✓ 12000 ÷ 100 OR 40000÷ 25 ✓ = 120 (N/cm^2)	**3** **(AO 1.2)** **(AO 2.1)** **(AO 2.1)**	**ALLOW** 12000÷25 for one mark **ALLOW** for two marks 480 (N/cm^2) **Examiner's Comments** Candidates are advised to start their response to this type of question by writing down the appropriate equation. They should then substitute the numbers from the stem of

					the question into the equation before they calculate the answer. Making sure to write down each stage of the process. A common error was candidates who had not allowed for the four tyres and gave a final answer of 480 N/cm^2.
	b	i	Reduces <u>pressure</u> / spreads the <u>force</u> / AW ✓	**1 (AO 1.1)**	**<u>Examiner's Comments</u>** Many candidates found it difficult to use appropriate technical language in their answers to this question (for example, force and pressure). Many candidates wrote vague responses such as 'it would cover more of the body' without explaining why this was important. Higher ability candidates used specific technical language such as 'reducing the pressure' or 'spreading the force'.  **AfL** The parts of a question form a story that develops a central theme. In part (a) looks at the pressure the car applies to the road, part (b) looks at the pressure that the force resulting from breaking applies to passengers, and part (c) applies this knowledge to the specific context of child safety seats. Where candidates follow these story lines, it helps them to improve the quality of their answers. However in (i) and (c) most candidates did not make the connection after they were asked to calculate pressure in (a).
		ii	Absorb energy (in a crash) ✓	**1 (AO 1.1)**	**ALLOW** higher level answers: eg. Reduces force / acceleration E.g. Increases time / distance to stop **<u>Examiner's Comments</u>** Higher ability candidates realised that the material was stretchy to absorb energy in a crash. Other responses referred to more generalised reasons such as allowing seatbelts 'to fit around different sized people.' Some candidates described the seat belt material as 'having a little give' or 'movement' without explicitly explain how this would increase time, reducing the rate of deceleration and thus the force exerted on the passenger.
	c		Mass / inertia of child is lower ✓	**2 (AO 2.1) (AO 1.1)**	**ALLOW** weight of child is lower/child is smaller

			Less force is needed (for the same deceleration)✓		**Examiner's Comments** Many candidates suggested that the narrower belts were needed because of child car seats are smaller.
			Total	**7**	
24	a		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 400 (Pa) award 2 marks** $P = 2 \div 0.005$ ✓ $P = 400$ (Pa) ✓	2 (AO2.1) (AO2.1)	**Examiner's Comments** Relatively few candidates had problems with dividing by 0.005.
	b		**Any three from:** Measure original length (using the ruler) ✓ Add the 2N weight ✓ Measure the extended length and use Extension = extended length – original length ✓ Use $k = F \div x$ to determine k ✓	3 (AO1.2 x3)	**ALLOW** measure the extension/how far it stretched **Examiner's Comments** Only a few candidates stated how the spring constant should be calculated by referring to *spring constant = force exerted by the spring ÷ extension*. However as the mark scheme allowed for any of the four marking points to count towards the total many candidates gained all 3 marks without reference to the spring constant equation. Exemplar 3 was a typical response and gained two marks. This candidate did realise a calculation was needed but decided it should be $E = ½ k x^2$. This energy equation (which was on the data sheet) was given in more candidate answers than the expected force = *extension x spring constant* **Exemplar 3** 18 A student has a spring, a ruler and a 2.0 N weight. (a) Describe how the student can use this equipment to determine the **spring constant** of the spring. the student can attach the spring to a stand and a clip, then put the weight on the end of the spring, measuring how far it extends. Then use the equation energy transferred in stretching = 0.5 × spring constant × (extension)² [3]
	c		Two (or more) forces (are needed) ✓ Acting in different directions ✓	2 (AO1.1) (AO1.1)	Multiple forces are implied by the use of certain verbs e.g. squash, twist, squeeze **ALLOW** the marking points shown on a diagram Idea of second force can be implied

					by fixing one end/part of the material **ALLOW** clear use of tension or compression for both marks **Examiner's Comments** The key factors which were needed here were that more than once force is necessary, and that those forces must act in different directions. The 'multiple forces' idea was accepted to be implied by the use of some verbs, for example squash, twist, squeeze and crush. The 'opposite directions' mark could be gained by setting up a situation where the opposition was obvious, for example by. putting the object on a table and pushing down from above
	d		Plastic – stays deformed (when force is removed) ✓ Elastic – returns to original shape (when force removed) ✓	2 (AO1.1) (AO1.1)	**ALLOW** permanently changed **Examiner's Comments** Around half of all candidates described plastic deformation and this almost always led on to a description of elastic deformation, or vice versa (a description elastic deformation leading into plastic deformation). Very few candidates only described one form of deformation.
			Total	**9**	
25	a	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.5 (N/cm) award 3 marks** (Spring constant =) force ÷ extension ✓ 2.0 ÷ 4.0 ✓ = 0.5 (N / cm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	**ALLOW** 3 marks for 50 N/m Needs algebraic or arithmetic rearrangement for this m.p. Choice of *F, ext* for wrong data point loses mp2 but can get mp3 for evaluation ecf.
		ii	**Any two from:** Repeat readings and calculate a mean/average ✓ Use more forces ✓ Plot data on a graph (and use a line of best fit) ✓ Use equipment with a higher resolution✓ Repeat experiment with different equipment (and compare results) ✓	2 (AO3.3b x 2)	
	b		**FIRST CHECK THE ANSWER ON ANSWER LINE**	2	**ALLOW** 3.8 (J)

			If answer = 0.8 (J) award 2 marks ½ x 40 x 0.2^2 ✓ = 0.8 (J) ✓	 (AO2.1) (AO2.1)	
	c	i	(moment of 2N weight) = 80 (N cm) ✓ (moment of 3N weight) = 150 (N cm) ✓	2 (AO2.1) (AO2.1)	**ALLOW** 1 mark if answers are reversed
		ii	Anti-clockwise (as anti-clockwise moment is larger than the clockwise moment) / left hand side goes down / AW✓	1 (AO3.1b)	**ALLOW** indication of rotation by an arrow on the diagram
			Total	**10**	