Marking Scheme

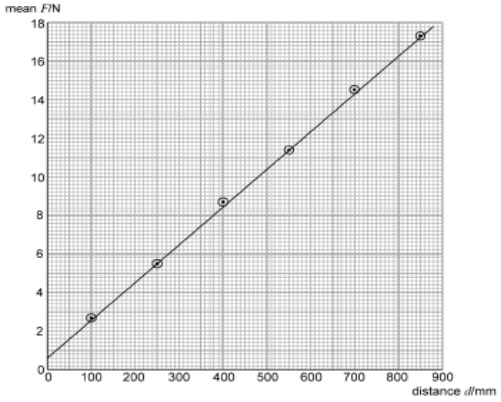
#1

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)		Moment of force about a point = Force × perpendicular distance from [not around] the point (to the line of action of the force). Accept symbol for perpendicular	1			1		
	(b)	(i)	Clockwise moment [CM] = 52 × 0.15 Or CM = 7.8 (N m) seen		1		1	1	
		(ii)	F × 0.58 = 8 or answer to (b)(i) or F × 0.58 =52 × 0.15 (ecf from (b)(i)) (1) F = 13.8 N (or 13.4 if 7.8 N m used – accept 13.5) (1) [Accept 2 s.f.] Correct answer → 2 marks		2		2	2	
	(c)		In position 2 [perpendicular] distance of weight from hinge is smaller (1) …. so CM decreased (1) So ACM reduced (1) so force in bar decreased and so Tom incorrect or Bethan correct (1) Or (converse argument): In position 1 [perpendicular] distance of weight from hinge is greater (1)… so CM increased (1) So ACM increased (1) So force in bar increased and so Tom incorrect or Bethan correct (1) Accept answers based on calculation Do not accept reference to Tom/Bethan being correct/incorrect without explanation Alternative explanation using vertical position of bar: In position 1 the bar is closer to the pivot (1) .. so to balance the clockwise moment (1).. the force in bar is increased so Tom incorrect / Bethan correct (1)			4	4		
			Question 1 total	**1**	**3**	**4**	**8**	**3**	**0**

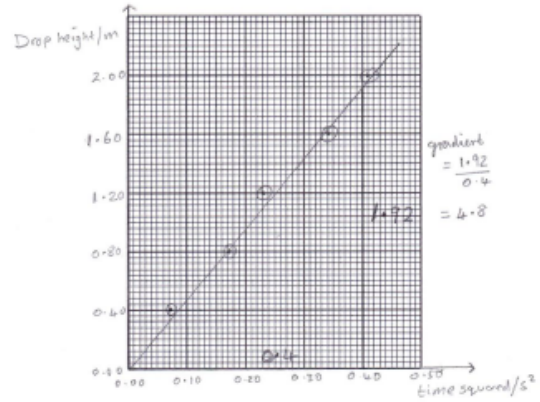
#2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)		No net force (1) Accept resultant of or sum of. Don't accept equal forces. No net moment (1) Accept all or sum of CM = sum of ACM	2			2		
	(b)		Moments taken about hinge. Clockwise moment shown to be 240 × 2 or 480 seen (1) Anticlockwise moment: T sin 35° × 1.4 seen (or cos 55°) (1) T = 597.8 [N] (1)		3		3	3	
	(c)	(i)	1.5 mm cable (1) Safe working load > than 600 N [at 3:1 ratio] **or** only just above 600 N so to be safe will use 2 mm cable (1)			2	2	1	
		(ii)	**Accept two** × (1) from the following options: • Shopkeeper does not have necessary expertise to decide on appropriate cable to use • Should seek advice of engineer as suggested on web page or expert advice • Shopkeeper should verify/ validate/ confirm/ authenticate wire rope data • Taken rod to be weightless • [If unsure] should have opted for higher diameter or applied higher safer working ratio • Weather/high winds could affect tension • Chosen wire does support the sign so made an informed choice			2	2		
			Question total	**2**	**3**	**4**	**9**	**4**	**0**

#3

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*			For a system to be in equilibrium (1) Σ anticlockwise moments [about a point] = Σ clockwise moments [about the same point] (1) N.B. Award 1 mark for Σ C.M = Σ A.C.M. only **Alternative:** For a system to be in equilibrium (1) algebraic sum of moments / net moment / resultant moment [about a point] = 0 (1)	2			2		
	(b)			Centre of gravity or line of action of weight remained inside lower surface of block [or equiv, e.g. CoG remains to left of pivot] Accept arrow clearly shown on diagram [1] Produces anticlockwise moment (or torque) [about pivot] [1]		2		2		2
	(c)	(i)		All mean F values determined correctly [1] Mean F / N: 2.7; 5.5; 8.7; 11.4; 14.6; 17.4 Or accept: Mean F / N: 2.7[0]; 5.45; 8.65; 11.4[0]; 14.55; 17.4[0]		1		1	1	1
		(ii)		$FL = W_B d + 490W_R$ (1) Manipulation and use of L = 980 to show $F = \frac{W_B d}{L} + \frac{490W_R}{980}$ (1) **Alternative:** $FL = W_B d + W_R \frac{L}{2}$ (1) $\therefore \left[FL = W_B d + W_R \frac{L}{2}\right] \rightarrow F = \frac{W_B d}{L} + \frac{W_R}{2}$ (1)		2		2	2	2
		(iii)		Titles and units on the axis correct i.e. (Mean) force or F / N, distance or d / mm (1) Suitable scales chosen so that the data points occupy at least ½ of each axis and not involving awkward factors, e.g. 3 (1) allow ecf from table All points plotted correctly to within ± ½ small square division ecf from table (1) Line of best fit drawn correctly **not through origin** (1) 		4		4	4	4
		(iv)	I.	Gradient calculated correctly e.g. $\frac{12.4 - 0.6}{600} = 0.02$ [1] W_B = gradient ecf × 980 e.g. = approx 19.6 [N] [1]			2	2	2	2
			II.	y-intercept determined correctly ± small square tolerance e.g. 0.7 [N] [1] W_R = 2 × y-intercept e.g.= 1.4 N ecf but don't apply for intercept of 0 [1]			2	2	2	2
	(d)			% Unc (d) calculated i.e. $1 \times \frac{100}{100} = 1\,\%$ [1] Uncertainty in (spread) $\Delta F = \frac{2.8 - 2.6}{2} = 0.1$ [1] $p_F = \frac{0.1\text{ecf}}{2.7} \times 100\,\% = 3.7\,\%$ [1] Ignore s.f.	1	1 1		3	3	3
	(e)			Any 1 × (1) of [Spirit] level / appropriate method to ensure that the ruler is horizontal Use digital forcemeter / forcemeter with a higher resolution Clamp stand to hold newtonmeter Repeat readings of force [due to random errors]			1	1		1
				Question 5 total	**3**	**11**	**5**	**19**	**14**	**17**

#4

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*	(i)	Magnitude of vertical force = 2.0×10^{-4} (N) (1) [Direction not required here] Application of Pythagoras and correct overall magnitude determined i.e $R^2 = (2.0 \times 10^{-4})^2 + (5.0 \times 10^{-4})^2$ $R = 5.4 \times 10^{-4}$ (N)[accept 5.38 or 5.39] (1) No ecf $\theta = 21.8°$ [tolerance of rounding errors] below horizontal [allow 112°, 22° South of E…] stated or clearly shown in diagram [accept 68.2° to the vertical stated or shown] ecf on R (1)		3		3	3	
		(ii)	Air resistance and force due to gravity [or weight] are equal [or air resistance = 6.0×10^{-4} N] hence no resultant force [accept forces balanced /cancel / no acceleration]	1			1		
	(b)	(i)	Subtract …0.05 [from readings (of time)] / ….the time delay / …it			1	1		1
		(ii)	<table><tr><td>Drop height h, (m)</td><td>0.40</td><td>0.80</td><td>1.20</td><td>1.60</td><td>2.00</td></tr><tr><td>Corrected time t, (s)</td><td>0.27</td><td>0.41</td><td>0.48</td><td>0.58</td><td>0.64</td></tr><tr><td>Corrected time squared t^2, (s^2)</td><td>**0.07(3)**</td><td>**0.17**</td><td>**0.23**</td><td>**0.34**</td><td>**0.41**</td></tr></table> All values of t^2 calculated correctly (1) [award this mark, even if sig figs incorrect] To 2 sig. fig. [Allow 1 sf on first answer] [see table] (1)		2		2	2	2
		(iii)	$x = ut + \frac{1}{2}at^2$ identified (1) Explanation that: [$x = h$], $u = 0$ *and* $a = g$ [or by implication] (1) No algebra required	1	1		2		
		(iv)	Suitable scale and both axes labelled correctly with appropriate units: [drop] height [h]/ m and time squared [t^2]/ s^2 [or (t / s)^2] (1) Allow ecf from table All 5 points plotted correctly ± ½ small square division (2) If 4 points plotted correctly ± ½ small square division (1) If 3 or less points plotted correctly ± ½ small square division (0) Appropriate line of best fit [through origin] (1) ecf 		4		4	4	4
		(v)	Suitable triangle shown on graph [or two points on line implied in calculation] with $\Delta h \geq 1.0$ m [or two appropriate points shown on line] See above (1) Gradient calculated correctly [Accept 4.6 to 5.0] (1) $g = 2 \times$ gradient [Allow ecf] (1) 2nd and 3rd mark can be awarded even if first mark withheld. [Allow final mark for correct answers using data points rather than gradient]			3	3	2	3
	(c)		Straight line / $h \propto t^2$ / linear graph (1) Through [or close to] origin (1) g close to accepted value / 9.81 or low degree of scatter / points close to line of best fit [accept relevant comment based upon candidate's graph] (1)			3	3		3
			Question 2 total	**2**	**10**	**7**	**19**	**11**	**13**

#5

(a)	(i)	Point where entire **weight** of object acts. Don't accept mass.	[1]
	(ii)	Tan $\theta = 40/60$ (1); $\theta = 33.7°$ (1)	[2]
(b)	(i)	$V = 0.6.x\ 0.4\ x\ 0.1$ (1); $M = \rho\ x\ V$ used correctly (1)	[2]
	(ii)	$T \sin\theta$ or equivalent (1) x 1.2 (1) = 9.6 x 9.81 x 1.8 (1) $T = 220$ [N] (1)	[4]
	(iii)	$F = 220$ (**ecf**) cos40° or equivalent (1) $F = 169$ [N] (1) Accept Pythagoras solution.	[2]
		Question 5 Total	**[11]**

#6

Question				Marking details	Marks Available
6	*(a)*			Point ← *d* → (1) *F* Moment = *Fd* (1) [award only if clear diagram shown] / if no right angle in diagram then **perpendicular** must be included in definition	2
	(b)	(i)		(*F* (sin 40°)(1) × 0.4) (1) = ((12 × 0.9) + (22 × 1.8)) (1) *F* = 196 [N] shown	3
		(ii)	(I)	Vertical component of force in strut = 126 [N] (1) Accept 128 [N] or 129 [N] if *F* = 200 N is used.	3
			(II)	Vertical **downward** arrow shown at hinge. (1)	
			(III)	Vertical force on bar due to hinge = 92 [N] (1) **ecf**	
				Question 6 Total	**[8]**

#7

(a)		No net force / all forces acting on the body are balanced / $\sum F=0$	[1]
(b)		$wx + F_2x_2$	[1]
(c)	(i)	1.2 [m] **and** 2.8 [m] – correctly labelled	[1]
	(ii)	w x 0.8 = 90 x 1.2 + 100 x 2.8 (1) (**ecf** on 1.2 and 2.8) w = 485 [N] (1)	[2]
	(iii)	R = 675 [N] (**ecf** on w)	[1]
	(iv)	Anticlockwise and clockwise moments calculated correctly (even as **ecf**) (1) Both = 2 160 [N m] **or** ∑moments about Q shown=0 (1)	[2]
	(v)	To the left (or towards P) (1) Increased clockwise moment needed to counteract increased anti-clockwise moment **or** sensible statement related to weight and distance (1)	[2]

#8

(a)		Replace *mass* with *force* (1) Don't accept weight Introduce *perpendicular distance to pivot* (1)	[2]
(b)		(2 × 700) – 1 200 (1) Weight of beam = 200 [N] (1) **Alternative solution:** Moment about A or B e.g. (700 × 5) = (1 200 + W) × 2.5	[2]
(c)	(i)	 Upward forces as shown and indicated (1) Downward forces as shown and indicated (1) N.B. 1 200 [N] force can be indicated anywhere between W and F_B	[2]
	(ii)	Taking moments about A: F_B × 5.0 (1) (1 200 × 3.5) + (200 × 2.5) (1) (**ecf** on 200) F_B = 940 [N] (1)	[3]
	(iii)	1 400 – 940 = 460 [N] (**ecf** from (*b*) and/or (*c*)(ii)) Accept answer based on moments calculated about B.	[1]

#9

(a)		Replace *mass* with *force* (1) Don't accept weight Introduce *perpendicular distance to pivot* (1)	[2]
(b)		$(2 \times 700) - 1\,200$ (1) Weight of beam = 200 [N] (1) **Alternative solution:** Moment about A or B e.g. $(700 \times 5) = (1\,200 + W) \times 2.5$	[2]
(c)	(i)	 Upward forces as shown and indicated (1) Downward forces as shown and indicated (1) N.B. 1 200 [N] force can be indicated anywhere between W and F_B	[2]
	(ii)	Taking moments about A: $F_B \times 5.0$ (1) $(1\,200 \times 3.5) + (200 \times 2.5)$ (1) (**ecf** on 200) $F_B = 940$ [N] (1)	[3]
	(iii)	$1\,400 - 940 = 460$ [N] (**ecf** from (*b*) and/or (*c*)(ii)) Accept answer based on moments calculated about B.	[1]
		Question 7 Total	**[10]**

#10

3	*(a)*		Moment [or torque / couple]	1
	(b)	(i)	$4.0 \times 0.40 = \Delta \times 0.20$ (1) [or by impl.] Wt of Δ = 8.0 N (1)	2
		(ii)	12.0 N (1)[ecf = 4.0 + *(b)*(i)]	1
	(c)	(i)	12(ecf)x (1) = 9.0(0.8 – *x*)(1) *x* = 0.34 m (1)	3
		(ii)	*x* needs to stay the same (1) because force/weight [and hence the moment] at C are unchanged (1) N.B. Ecf from *(b)*(ii)	2
				[9]