Forces

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Forces, Density & Pressure
Sub Topic	Forces
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **88 minutes**

Score: **/73**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1	**(a**	resultant moment = zero / sum of clockwise moments = sum of anticlockwise moments	B1	
		resultant force = 0	B1	[2]
	(b)	shape and orientation correct and forces labelled and arrows correct	M1	
		angles correct / labelled	A1	[2]
	(c) **(i)**	$T \cos 18° = W$ Scale diagram:	C1	
		$T = 520 / \cos 18° = 547$ N ± 20 N	A1	[2]
	(ii)	$R = T \sin 18°$		
		= 169 N ± 20 N	A1	[1]
	(d)	θ is larger hence $\cos\theta$ is smaller, $T = W / \cos\theta$	M1	
		hence T is larger	A0	[1]
2	**(a**	no resultant force/sum of forces zero	B1	
		no resultant moment/torque/sum of moments/torques zero	B1	[2]
	(b) **(i)**	each force is represented by the side of a triangle/by an arrow	M1	
		in magnitude and direction	A1	
		arrows joined, head to tail	B1	[3]
		(*could be shown on a sketch diagram*)		
	(ii)	if the triangle is 'closed' (then the forces are in equilibrium)	B1	[1]
	(c)	triangle drawn with correct shape (incorrect arrows loses this mark)	B1	
		$T_1 = 5.4 \pm 0.2$ N	B	
		$T_2 = 4.0 \pm 0.2$ N	B	[3]
	(d)	forces in strings would be horizontal	B1	
		(so) no vertical force to support the weight	B1	[2]

3	**(a**	**(i)**	point at which whole weight of body	M1	
			may be considered to act	A1	**[2]**
		(ii)	sum of forces in any direction is zero	B1	
			sum of moments about any point is zero	B1	**[2]**
	(b)		*either*:		
			T and W have zero moment about P	M1	
			so F must have zero moment, i.e. pass through P	A1	**[2]**
			or:		
			if all pass through P, distance from P is zero for all forces so	(M1)	
			sum of moments about P is zero	(A1)	
	(c)	**(i)**	$F\cos\alpha = T\cos\beta$	B1	**[1]**
		(ii)	$W = F\sin\alpha + T\sin\beta$	B1	**[1]**
		(iii)	$2W = 3T\sin\beta$	B1	**[1]**

4	**(a**	**(i)**	(vertical component = 44 sin 30° =) 22 N	A1	[1
		(ii)	(horizontal component = 44 cos 30° =) 38(.1) N	A1	[1
	(b)		$W \times 0.64 = 22 \times 1.60$	C1	
			(W =) 55 N	A1	[2]
	(c)		F has a horizontal component (not balanced by W) or F has 38 N acting horizontally or 38 N acts on wall or vertical component of F does not balance W or F and W do not make a closed triangle of forces	B1	[1
	(d)		line from P in direction towards point on wire vertically above W and direction up	B1	[1]

5	**(a**	displacement / velocity / acceleration / momentum / etc. three correct (none wrong) 2, two correct (none or one wrong) 1	A2	[2]
	(b) (i)	Y = 70 N [allow 71 N as +½ small square on graph]	A1	[1]
	(ii)	$\theta = 90°$	M1	
		(for equilibrium) the direction of Y must be <u>opposite</u> to Z		
		or using $Y \sin \theta = Z$, hence $\sin \theta = 70 / 70 = 1$, $\theta = 90°$	A1	[2]
	(iii) 1.	$Y \cos \theta = 160$ and $Y \sin \theta = 70$	C1	
		$\tan \theta = 70 / 160$ hence $\theta = 23.6°$ (24°)	A1	[2]
	2.	Y = 160 / cos 23.6° or 70 / sin 23.6° = 174.6 or 175 or 170 N	C1 A	 [2]
		or:		
		$160^2 + 70^2 = Y^2$ Y = 174.6 or 175 or 170 N	(C1) (A1)	
	(c)	(equilibrium not possible as) there is no vertical component from Y to balance Z	B1	[1]

6	**(a**	torque is the product of one of the forces and the distance between forces the <u>perpendicular</u> distance between the forces	M1 A1	 [2]
	(b) (i)	torque = 8 × 1.5 = 12 N m	A1	[1]
	(ii)	there is a resultant torque / sum of the moments is not zero (the rod rotates) and is not in equilibrium	M1 A1	 [2]
	(c) (i)	B × 1.2 = 2.4 × 0.45 B = 0.9(0) N	C1 A1	 [2]
	(ii)	A = 2.4 – 0.9 = 1.5 N / moments calculation	A1	[1]

7	**(a**	point where the weight of an object / gravitational force may be considered to act	M1 A1	[2]
	(b)	product of the force and the <u>perpendicular</u> distance (to the pivot)	B1	[1]
	(c) (i)	1. sum / net / resultant force is zero	B1	
		2. net / resultant moment is zero sum of clockwise moments = sum of anticlockwise moments	B1	[2]
	(ii)	$W \times 0.2 = 80 \times 0.5 + 70 \times 1.3$ $= 40 + 91$ $W = 655$ N (*allow 2/3 for one error in distance but 0/3 if two errors*)	C1 C1 A1	[3]
	(iii)	move pivot to left gives greater clockwise moment / smaller anticlockwise moment *or* move W to right gives smaller anticlockwise moment	(M1) (A1) (M1) (A1)	[2]
8	**(a**	3.5 *T*	B1	[1
	(b)	distance = average speed × time (however expressed) = 14 m	C1 A1	[2]
	(ii)	distance = 5.6 × (*T* – 5) (*or 3.5T – 14*)	A	[1]
	(c)	$3.5T = 14 + 5.6(T - 5)$ $T = 6.7$ s	C1 A1	[2]
	(d) (i)	acceleration = (5.6 / 5 =) 1.12 m s^{-2} force = *ma* = 75 N	C1 C1 A1	[3]
	(ii)	power = (force × speed =) {75 + 23} × 4.5 = 440 W (*allow 1/2 for 234 W, 0/2 for 338 W or 104 W*)	C1 A1	[2]