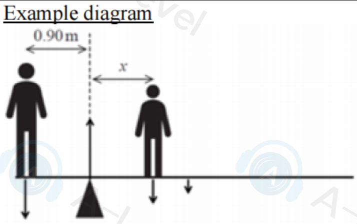
2	**The only correct answer is A (The resultant force is zero and the resultant moment is zero)** B is not correct because the resultant moment should be zero C is not correct because the resultant force should be zero D is not correct because the resultant force should be zero and the resultant moment should be zero	1

8	**B to the left of O**	1
	Incorrect Answers: the centre of mass has moved to the left of O. The right-hand half has double the density but half the diameter so the weight is $(2 \times \frac{1}{(2)^2} =) \frac{1}{2}$ the original weight. The pivot needs to be placed under the centre of gravity for the rod to balance. A – O is no longer the position of the centre of gravity C – The centre of gravity is to the left of O and not the right D – There is a balance point but, so that there is equal weight either side of the centre of gravity, its position has moved to the left	

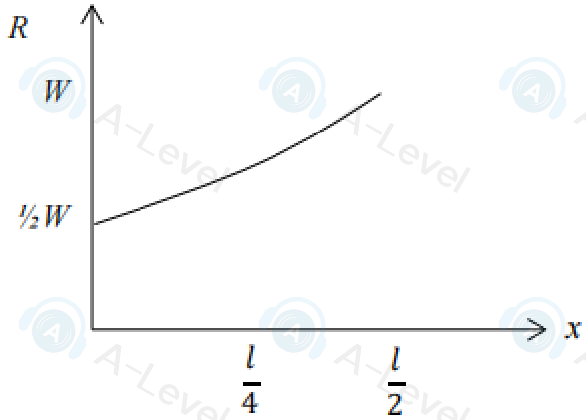
5	**B is the correct answer** A is incorrect because the CW moment of the force could balancethe ACW moment of the weight C is incorrect because the CW moment of the force could balance theACW moment of the weight D is incorrect because the CW moment of the force could balance the ACW moment of the weight	1

10	**The only correct answer is A ($\frac{Fx}{y} + F$)** B is not correct because $W = \frac{Fx}{y} + F$ C is not correct because $W = \frac{Fx}{y} + F$ D is not correct because $W = \frac{Fx}{y} + F$	1

Question Number	Answer		Mark
13(a)	• Use of $\Sigma F = 0$, seen or implied • $F = 11$ N • Use of moment of force = Fx (with any corresponding force and known distance from an end, A or midpoint) • Use of the principle of moments • $x = 0.86$ m	(1) (1) (1) (1) (1)	**5**
	<u>Example of calculation</u> $F_A + F_B = 8.5 \text{ N} + 14 \text{ N} = 22.5 \text{ N}$ $F_A = F_B$ $2F = 22.5$ N $F = 11.25$ N if moments taken from the left end $(11.25 \text{ N} \times 0.15 \text{ m}) + (11.25 \text{ N} \times x) = (8.5 \text{ N} \times 0.35 \text{ m}) + (14 \text{ N} \times 0.60 \text{ m})$ $x = 0.861$ m if moments taken from midpoint $(11.25 \text{ N} \times 0.45 \text{ m}) = (11.25 \text{ N} \times x) + (8.5 \text{ N} \times 0.25 \text{ m})$ $x = 0.261$ m so distance = 0.261 m + 0.6 m = 0.861 m if moments taken from A $(8.5 \text{ N} \times 0.20 \text{ m}) + (14 \text{ N} \times 0.45 \text{ m}) = (11.25 \text{ N} \times x)$ $x = 0.711$ m so distance = 0.711 + 0.15 m = 0.861 m		
13(b)	The moment (of B) must be the same For a smaller distance (from the left end of the shelf), the (normal contact) force must increase	(1) (1)	**2**
	Total for question 13		**7**

Question Number	Acceptable Answer	Additional Guidance	Mark
11(a)	Three downward arrows to show the forces of the people and the weight of the plank **(1)** Upward arrow to show reaction force at the pivot **(1)**	Example diagram 	2
11(b)	Use of moment = $F\,x$ **(1)** Application of principle of moments **(1)** $x = 0.89$ m **(1)**	Example calculation $950\text{ N} \times 0.90\text{ m} = \left(\frac{4.0\text{ m}}{2} - 0.90\text{ m}\right) \times 250 + x \times 650\text{ N}$ $x = \frac{(950\text{ N} \times 0.90\text{ m}) - (1.10\text{ m} \times 250\text{ N})}{650\text{ N}}$ $x = \frac{855\text{ Nm} - 275\text{ Nm}}{650\text{ N}} = 0.89\text{ m}$	3

(Total for Question 11 = 5 marks)

Question Number	Answer		Mark
13(a)	• Point at which weight is taken to act.	(1)	**(1)**
13(b)	• Gradient everywhere positive • Stops at R = weight/W/mg at $l/2$ • Starts at R = ½ weight/0.5W/0.5mg etc. 	(1) (1) (1)	**(3)**
13(c)	• Centre of gravity/mass is not above the shelf. **Or** Line of action of weight does not pass through the shelf. • There is a net moment clockwise. **Or** No anticlockwise moment to balance moment of weight.	(1) (1)	**(2)**
	Total for question 13		**6**

Question Number	Answer		Mark
16(a)	Resultant force is zero Resultant moment (about any point) is zero	**(1)** **(1)**	**2**

Question Number	Answer		Mark
16(a)	Resultant force is zero	(1)	
	Resultant moment (about any point) is zero	(1)	2
16(b)	Use of Moment of force $= Fx$	(1)	
	Use of principle of moments with dish in original position	(1)	
	Uses total weight = weight of rice + weight of dish to determine weight of one portion of rice	(1)	
	Use of principle of moments with dish in new position **Or** Calculates clockwise moment with 3 portions of rice in new position **and** calculates anticlockwise moment of weight of beam	(1)	
	Dish contains 8.2 portions of rice	(1)	
	Comparison with 3 portions **and** consistent conclusion	(1)	6
	<u>Example calculation</u> Moment of weight of beam = $3.1\text{ N} \times 0.08\text{ m} = 0.248\text{ N m}$ $0.248\text{ N m} = (\text{weight of dish and rice}) \times 0.25\text{ m}$ Weight of dish and rice $= \dfrac{0.248\text{ N m}}{0.25\text{ m}} = 0.992\text{ N}$ Weight of one portion of rice = 0.992 N – 0.64 N = 0.352 N 0.248 N m = (portions × 0.352 N + 0.64 N) × 0.07 m Number of portions = $\dfrac{\frac{0.248\text{ N m}}{0.07} - 0.64\text{ N}}{0.352\text{ N}} = 8.247$ The dish contains 8.2 portions, not 3 portions of rice		
	Total for question 16		**8**

18(a)	No resultant force No resultant moment (about any point)	**(1)** **(1)**	**2**
18(b)	The point at which the weight of an object is considered to act	**(1)**	**1**
18(c)(i)	Use of $W = mg$ Horizontal distance from edge of door to centre of gravity identified as $\frac{w}{2}$ Use of moment of force $= Fx$ Use of clockwise moment = anticlockwise moment Horizontal component of force of hinge Y on door = 37.5 (N) **OR** Use of $W = mg$ Use of tan θ with dimensions of door Use of vertical component of force of hinge Y on door = W/2 Use of tan θ with vertical and horizontal components of force of hinge Y on door Horizontal component of force of hinge Y on door = 37.5 (N) <u>Example of calculation</u> $W = 14.4\text{ kg} \times 9.81\text{N kg}^{-1} = 141\text{ N}$ $141\text{ N} \times \frac{0.85\text{ m}}{2} = F_{\text{horizontal}} \times 1.60\text{ m}$ $F_{\text{horizontal}} = \frac{60.0\text{ N m}}{1.60\text{ m}} = 37.5\text{ N}$	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**5**

18(a)	No resultant force No resultant moment (about any point)	(1) (1)	2
18(b)	The point at which the weight of an object is considered to act	(1)	1
18(c)(i)	Use of $W = mg$ Horizontal distance from edge of door to centre of gravity identified as $\frac{w}{2}$ Use of moment of force $= Fx$ Use of clockwise moment = anticlockwise moment Horizontal component of force of hinge Y on door = 37.5 (N) **OR** Use of $W = mg$ Use of tan θ with dimensions of door Use of vertical component of force of hinge Y on door = W/2 Use of tan θ with vertical and horizontal components of force of hinge Y on door Horizontal component of force of hinge Y on door = 37.5 (N) <u>Example of calculation</u> $W = 14.4\text{ kg} \times 9.81\text{N kg}^{-1} = 141\text{ N}$ $141\text{ N} \times \frac{0.85\text{ m}}{2} = F_{\text{horizontal}} \times 1.60\text{ m}$ $F_{\text{horizontal}} = \frac{60.0\text{ N m}}{1.60\text{ m}} = 37.5\text{ N}$	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	5

18(c)(ii)	Use of appropriate trigonometry to determine θ θ = 28° (allow ecf from 18(c)(i)) (show that answer gives 30°) Use of Pythagoras' theorem to determine F **Or** Use of appropriate trigonometry to determine F F = 80 N (allow ecf from 18(c)(i)) (show that answer gives 81 N) <u>Example of calculation</u> $\theta = \tan^{-1}\left(\frac{37.5}{\left(\frac{141}{2}\right)}\right) = 28.0°$ $F = \sqrt{(37.5\text{ N})^2 + \left(\frac{141\text{ N}}{2}\right)^2} = 80.0\text{ N}$	**(1)** **(1)** **(1)** **(1)**	 **4**
18(c)(iii)	Moment of weight of door (about X) remains the same. **Or** $mg \times \frac{w}{2} = F_{\text{horizontal}} \times L$ (and m, g and w remain the same). (So) horizontal (component of) force increases (when L decreases). Vertical (component of) force remains the same. **Or** Each hinge still holds half the weight of the door. (So) F increases and θ increases.	**(1)** **(1)** **(1)** **(1)**	 **4**
	Total for question 18		**16**