Mark Scheme

Q1.

Question Number	Acceptable answers	Additional guidance	Mark
	• The position of the centre of gravity moves to the left/backwards **Or** the perpendicular distance (from O) would be greater **(1)** • The moment of the bag (about O) increases so the moment of R (and the size of R) decreases to preserve equilibrium **(1)**	MP1: accept lower for to the left	**2**

Q2.

Question Number	Acceptable answers	Additional guidance	Mark
	• Use of moment = force × perpendicular distance **(1)** • Use of clockwise moments = anticlockwise moments **(1)** • Position of centre of gravity = 27 cm from base **(1)**	MP1 not awarded if cos θ not used or sin θ not used Example of calculation (18.5 kg × 9.81 N kg^{-1}) × x cos θ = 50 N × 0.97 m × cos θ x = 0.27 m	**3**

Q3.

Question Number	Acceptable answers	Additional guidance	Mark
	• The weight does not act through the nail/pivot **Or** the centre of gravity is not in line/below the nail/pivot **Or** there is a perpendicular distance between the weight and the nail/pivot (1) • There is now a moment of the weight **Or** the anticlockwise moment is greater than the clockwise moment (1) • The idea that the picture stops moving when the c of g is below the nail (1)	Accept centre of mass for centre of gravity (Allow annotations to a diagram with additional explanation for MP1/3) MP3 Accept: the turning moment being 0 **Or** the clockwise moments equal to the anti-clockwise moments	3

Q4.

Question Number	Acceptable answers	Additional guidance	Mark
(i)	**MAX 2** • Statement describing 740cos20 as the (perpendicular) component of weight of the hiker **and** Statement describing Wcos20 as the (perpendicular) component of the weight of the bag (1) (1) • 2R is the push of the ground on the hiker (1) • Use of $\Sigma F = 0$ with reference to hiker being stationary	Accept reaction force	2

Question Number	Acceptable answers		Additional guidance	Mark
(ii)	• See 740 N × 0.25 m × cos 20 (= 173.8 N m)	(1)	Example of calculation Moment of the weight of the man: 740 N × 0.25 m × cos 20 = 173.8 N m Moment of the weight of the bag: W × 0.10 m × cos 20 = 0.0940W N m Moment of R: R × 0.40 m = 0.40R N m 173.8 N m = 0.40R + 0.0940W N m Re-arranging to make R the subject of the equation: R = 435 N – 0.235W N Re-arranging the equation for the resultant force: R = 347.7 N + 0.470W 435 N – 0.235W N = 347.7 N + 0.470W 0.705W = 87.3 W = 124 N	6
	• See W × 0.10 m × cos 20 (= 0.0940W N m) **Or** 0.5(740cos20 + Wcos20)	(1)		
	• See R × 0.40 m (= 0.40N N m)	(1)		
	• Use of principle of moments e.g. substitution into: moment of weight of man = moment of weight of bag + moment of R	(1)		
	• Use of equation of the resultant force with the equation obtained in MP4 **OR** Use of principle of moments about another point with the equation obtained in MP4	(1) (1)		
	• W = 120 N			

Q5.

Question Number	Acceptable Answer		Additional Guidance	Mark
(a)	• Use of $W = mg$	(1)	Example of calculation Mass of water = 85.0 litres × 1 kg = 85.0 kg Mass of base and water = 85.0 kg + 3.50 kg = 88.5 kg Weight of base = 88.5 kg × 9.81 N kg^{-1} = 868.2 N	2
	• W = 868 (N)	(1)		

Question Number	Acceptable Answer		Additional Guidance	Mark
(b)	• See 868 N × 0.45 m × cos 15 (= 377.3 N m)	(1)	MP1 accept sin75 for cos15	
	• See 27 N ×2.0 m × cos 75 (= 13.98 N m)	(1)	MP2 accept sin15 for cos75	
	• See F_w ×2.4 m × cos 15 (= 2.31F_w)	(1)	MP3 accept sin75 for cos15	
	• Use of principle of moments e.g. substitution into: moment of weight of base = moment of weight of post arrangement + moment of wind	(1)	MP4, accept > correctly used in place of = to indicate the point at which it will tip and ecf for W from 11 (a)	
	• F_w = 157 or 158 N	(1)	<u>Example of calculation (using perpendicular forces)</u> Moment of weight of base = 868 N × cos 15 × 0.45 m = 377.29 Nm	
			Moment of the post arrangement = 27.0 N × cos 75 × (2.80 m – 0.80 m) = 13.98 N m	
			Moment of the wind = F_w × cos 15 × 2.40 m = 2.31 F_w	
			377.29Nm = 13.98 Nm + 2.31 F_w	
			F_w = 157.28 N	
			<u>Example of calculation (using perpendicular distances)</u> (868 N × 0.45 m × cos 15) = (27 N ×2.0 m × cos 75) + (F_w ×2.4 m × cos 15) F_w = 156.72 N	5

Question Number	Acceptable Answer		Additional Guidance	Mark
(c)	• F_w would increase	(1)		
	• The <u>weight</u> of the base would be heavier/increase	(1)		
	• This increases the clockwise moment **Or** this increases the moment of the (weight of the) base	(1)		3