Question	Paper 32– Mechanics Mark Scheme	Marks
1(a)	$\boldsymbol{a} = 6t^2\ \boldsymbol{i} + 8t^3\ \boldsymbol{j}$	M1
	$\boldsymbol{u} = \int 6t^2\boldsymbol{i} + 8t^3\boldsymbol{j}\ dt = 2t^3\boldsymbol{i} + 2t^4\boldsymbol{j} + \boldsymbol{c}$ At $t = 0,\ \boldsymbol{u} = 400\boldsymbol{i}$ Hence $\mathbf{c} = 400\boldsymbol{i}$	
	$\boldsymbol{x} = \int (2t^3 + 400)\boldsymbol{i} + (2t^4)\boldsymbol{j}\ dt = \left(\frac{1}{2}t^4 + 400t\right)\boldsymbol{i} + \left(\frac{2}{5}t^5\right)\boldsymbol{j} + \boldsymbol{c}$ At $t = 0, \boldsymbol{x} = 0$ Hence $\mathbf{c} = 0$	M1
	Displacement at $t = 10$ $\left(\frac{1}{2}(10)^4 + 400(10)\right)\boldsymbol{i} + \left(\frac{2}{5}(10)^5\right)\boldsymbol{j} = 9000\boldsymbol{i} + 40000\boldsymbol{j}$	M1
	$\sqrt{9000^2 + 40000^2}$	M1
	$\sqrt{9000^2 + 40000^2} = 41000$ m	B1
		(5)
1(b)	For use of $\tan\theta$ with 40000 and 9000 or values found in part(a)	M1
	$\tan\theta = \frac{40000}{9000}$	M1
	$\theta = 77.3°$	B1
		(3)
2	Boat A: $u = 20, v = 20, a = 0, s = s, t = t$ $s = ut + \frac{1}{2}at^2$ $s = 20t + \left(\frac{1}{2} \times 0 \times t^2\right)$	M1
	$s = 20t$	M1
	Boat B: $u = 15, v = v, a = 2, s = s, t = (t - 4)$ $s = ut + \frac{1}{2}at^2$ $s = 15(t - 4) + (\frac{1}{2} \times 2 \times (t - 4)^2)$	M1
	$s = t^2 + 7t - 44$	M1
	Equates found equations and rearranges to given form $20t = t^2 + 7t - 44$ $t^2 - 13t - 44 = 0$	A1
		(5)

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3(a)	Identifies vertical component of pulling force $25\sin 30$ $25\sin(30) + R = 15g$ $R = 134.5$ N	M1 M1 B1 **(3)**
3(b)	At least one of $25\cos 30 \ -\mu R$ **or** 15×0.2 $25\cos(30) - \mu R = 15 \times 0.2$ $\mu = 0.139$ (3 sf)	M1 M1 B1 **(3)**
4(a)	Horizontal velocity $= u\cos(\theta)$ always Attempts to use Pythagoras to find vertical velocity: $(u\cos(\theta))^2 + v^2 = (2u)^2$ $v = -u\sqrt{4 - \cos^2(\theta)}$ (negative root only as v is downwards vertical velocity) Attempts to use $v^2 = u^2 + 2as$ $u^2(4 - \cos^2(\theta)) = u^2\sin^2(\theta) - 2 \times 9.8 \times 9$ Attempts to rearrange e.g. $u^2\left(4 - \left(\sin^2(\theta) + \cos^2(\theta)\right)\right) = 176.4$ $u = 7.67$ ms^{-1}	M1 M1 M1 accept finding v^2 only M1 M1 B1 **(6)**
	Attempt to use $v = u + at$ $-7.67\sqrt{4 - \cos^2(\theta)} = 7.67\sin(\theta) - 9.8 \times 2$ Attempt to rearrange e.g. $4 - \cos^2(\theta) = \sin^2(\theta) - \frac{2 \times 9.8 \times 2}{7.67}\sin(\theta) + \left(\frac{9.8 \times 2}{7.67}\right)^2$ Rearrange to get $\sin(\theta)$ on one side e.g. $\sin(\theta) = \frac{7.67}{39.2}\left(\left(\frac{19.6}{7.67}\right)^2 - 3\right)$ $\theta = 43.7°$ **Accept alternate methods using any SUVAT equation other than $v^2 = u^2 + 2as$**	M1 M1 M1 B1 **(4)**

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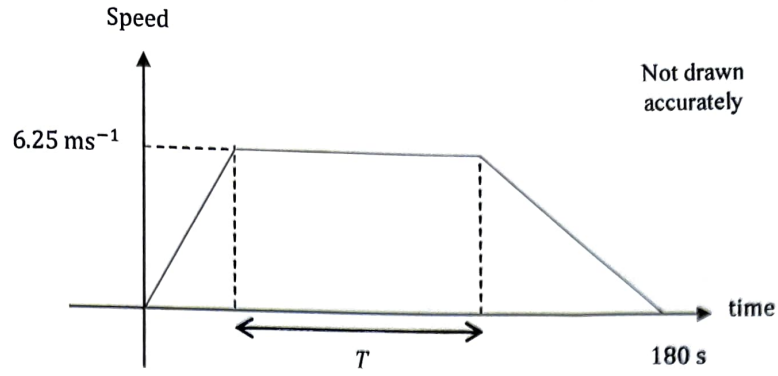
5(a)		B1 Graph clearly split into 3 distinct parts B2 Fully correct graph **(2)**
5(b)	Process to find area under the graph e.g. $\frac{1}{2} \times 6.25 \times (T + 180) = 1000$ $T = 140$ seconds	M1 B1 **(2)**
6(a)	Expressions for magnitude of reaction at P and Q e.g. $P: R$ **and** $Q: 3R$ May be implied by working Resolves vertically $R + 3R = 50g$ 122.5 N	M1 M1 B1 **(3)**
6(b)	Clockwise moment about $P = 50g(CA - 1.8)$ Anti-clockwise moment about $P = 37.5g(15 - 1.8 - 2.4)$ $50g(CA - 1.8) = 37.5g(15 - 1.8 - 2.4)$ Begins process to solve e.g. $CA - 1.8 = \frac{3}{4}(15 - 1.8 - 2.4)$ $AC = 9.9$ m	M1 M1 M1 M1 B1 **(5)**