4728 Mechanics 1

1 (i)	0.5x6 = 0.5x0.8 + 4m m = 0.65	M1 A1 A1 [3]	Uses CoLM If g used throughout, possible 3 marks
(ii)	0.5x6 = - 0.5x0.8 + 4m m = 0.85	M1 A1 A1 [3]	After momentums opposite signs If g used throughout, 0 marks
2 (i)	T = 400 N D = 400 + 900 = 1300 N	B1 M1 A1 [3]	Order immaterial Or T + 900; sign correct
(ii)	 500x0.6 = T - 400 T = 700 N 1250x0.6 = D - 900 -700 D = 2350 N *OR* (500 + 1250)x0.6 = D - 400 - 900 D = 2350 N	 M1 A1 A1 M1 A1ft A1 M1 A1 A1 [6]	(Award M marks even if g included in ma terms. M marks require correct number forces) Uses N2L one object only Uses N2L other object ft cv(T from (ii)); allow T instead of its value Uses N2L for both objects
3 (i)	5cos30 or 5 sin 60 or 4.33 5cos 60 or 5sin30 or 2.5	B1 B1 [2]	Order immaterial, accept +/-. May be awarded in (ii) if no attempt in (i)
(ii)	7-4.33 (= 2.67) and 9 - 2.5 (= 6.5) R^2 = 2.67^2 + 6.5^2 R = 7.03 tanθ = 6.5/2.67 θ = 67.6, 67.7degrees	M1* A1 D*M1 A1 D*M1 A1 [6]	Subtracts either component from either force 3sf or better Valid trig for correct angle 3sf or better
4 (i)	20cos 30 20cos30 = 3a a = 5.77 ms^{-2}	M1 M1 A1 [3]	Resolves 20 (accept 20 sin30) Uses N2L horizontally, accept g in ma term
(ii)	R = 3x9.8 + 20 sin 30 (= 39.4) F = 20cos 30 (= 17.3) 17.3 = 39.4μ μ = 0.44	M1 A1 B1 M1 A1 [5]	Resolves vertically (accept -, cos if sin in i); correct no. terms Correct (Neither R nor *F* need be evaluated) Uses F = μR

5 (i)	$V = \int 0.8t\,dt$	M1*	Attempt at integration
	$v = 0.8t^2 /2 \ (+c)$	A1	Award if c omitted
	$t = 0, v = 13, (c = 13)$	M1	
	$v = 0.4 \times 6^2 \ (+c)$	D*M1	
	$v = 27.4 \ ms^{-1}$	A1	
		[5]	
(ii)	$s = \int 0.4t^2 \ (+c)\,dt$	M1*	Attempt at integration of v(t)
	$s = 0.4t^3/3 + 13t \ (+k)$	A1ft	ft cv(v(t) in (i))
	$t=0, s=0, (k=0)$	M1	
	$s = 0.4 \times 6^3/3 + 13 \times 6$	D*M1	
	$s = 106.8 \ m$	A1	Allow if k=0 assumed. Accept 107 m.
		[5]	
(iii)	Fig. 2	B1	
		[1]	
	Fig.1 has zero initial velocity/gradient	B1	
	Fig. 3 does not have a increasing velocity/gradient	B1	
		[2]	
6 (i) a	$2.5 = 9.8t^2/2$	M1	Uses $s = 0 +/- gt^2/2$
	$t = 0.714$ s or better or 5/7	A1	Not awarded if - sign "lost"
b		[2]	
	$v^2 = 2 \times 9.8 \times 2.5$ *OR* $v = 9.8 \times 0.714$	M1	Uses $v^2 = 0 +/-2gs$ or $v = u +/- gt$
	$v = 7 \ ms^{-1}$ or 6.99 or art 7.00	A1	Not awarded if - sign "lost"
		[2]	
(ii)	$R = 2 \times 9.8\sin60 \ (= 16.97 = 17)$	B1	With incorrect angle, e.g
		M1	$R = 2 \times 9.8\cos60 \ (=9.8)$ B0
	$F = 0.2 \times 16.97 \ (=3.395$ or $3.4)$	A1ft	$F = 0.2 \times 9.8 \ (=1.96)$ M1A1√
	Cmpt weight $= 2 \times 9.8\cos60 \ (= 9.8)$	B1	Cmpt wt $= 2 \times 9.8\sin60 \ (=16.97)$ B0
	$2a = 9.8 - 3.395$	M1	$2a = 16.97 - 1.96$ M1
	$a = 3.2 \ ms^{-2}$	A1ft	$a = 7.5$ A1√ ft cv(R and Cmpt weight)
	Distance down ramp $= 5$ m	B1	
	$v^2 = 2 \times 3.2 \times 5$	M1	$v^2 = 2 \times 7.5 \times 5$
	$v = 5.66$ or 5.7	A1ft	$v = 8.66$ or 8.7 A1√ ft cv(√ (10a))
		[9]	
7 (i)		M1	Use of $v = u - 0.4t$
	$p = 4 - 2 \times 0.4 \ (= 3.2)$	A1	
	$q = 1 - 2 \times 0.4 \ (= 0.2)$	A1	Accept $q = -0.2$ from $-1+2*0.4$
		M1	Uses CoLM on reduced velocities
	$0.7 \times 3.2 - 0.3 \times 0.2 = (1 \times)v$	A1	
	$v = 2.18 \ ms^{-1}$	A1	
		[6]	

(ii) **a**		B1	Straight line with larger y intercept slopes towards t axis, but does not reach it.
		B1	Straight line with negative y intercept slopes towards t axis,
		B1	and gets to t axis before other line ends.
		[3]	**SR** if t=2 in ii give B1 if line stops before axis
b	$0 = 1 - 0.4t$	M1	Finds when Q comes to rest (any method)
	$t = 2.5$ s	A1	
		M1	Uses $s = ut - 0.4t^2/2$
	$P = 4 \times 3 - 0.5 \times 0.4 \times 3^2$	A1	
	$Q = 1 \times 2.5 - 0.5 \times 0.4 \times 2.5^2$	A1	(nb $0^{(2)} = 1^{(2)} - 0.4Q^2/2$ B1; convincing
	$PQ = 10.2 + 1.25 = 11.45$ m	A1	evidence (graph to scale, or calculation that Q comes to rest and remains at rest at t less than 3, M1A1; graph A1 needs –ve v intercept)
		[6]	**SR** if t=2 in iib, allow M1 for s= ut - 0.4t²/2 And A1 for PQ=8.4

Alternative for Q3 where 7 N and 9N forces combined initially

3 (i)	5cos30 or 5 sin 60 or 4.33	B1	Order immaterial, accept +/-. May be awarded
	5cos 60 or 5sin30 or 2.5	B1	in (ii) if no attempt in (i)
		[2]	
(ii)	$Z^2 = 7^2 + 9^2$ (= 130, Z = 11.4017...)		Z is resultant of 7N and 9N forces only
	cos(angle of Z with y axis) = 9/11.4017..		
	angle of Z with y axis = 37.8746...		
	Angle opposite R in triangle of forces =		R is resultant of all 3 forces
	180 -(37.8746+90+30)	M1*	Complete method
	= 22.125 (Accept 22)	A1	
	$R^2 = 5^2 + 11.4017^2 - 2 \times 5 \times 11.4017\cos22.125$	D*M1	Cosine rule to find R
	R (= 7.0269) = 7.03 N	A1	
	$11.4017^2 = 5^2 + 7.0269^2 - 2 \times 5 \times 7.0269\cos A$		Or Sine Rule. A is angle between R and 5N
	(A = 142.33)		forces
	Angle between R and y axis = 142.33-30-	D*M1	
	90 (=22.33)		Complete method
	θ (= 90-22.33) =67.7 degrees	A1	θ is angle between R and x axis
		[6]	