4728 Mechanics 1

1 (i)	$0.5 \times 6 = 0.5 \times 0.8 + 4m$ $m = 0.65$	M1 A1 A1 [3]	Uses CoLM If g used throughout, possible 3 marks
(ii)	$0.5 \times 6 = -0.5 \times 0.8 + 4m$ $m = 0.85$	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)	 $500 \times 0.6 = T - 400$ $T = 700$ N $1250 \times 0.6 = D - 900 - 700$ $D = 2350$ N *OR* $(500 + 1250) \times 0.6 = D - 400 - 900$ $D = 2350$ 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 $9 - 2.5 \ (= 6.5)$ $R^2 = 2.67^2 + 6.5^2$ $R = 7.03$ $\tan\theta = 6.5/2.67$ $\theta = 67.6, 67.7$ degrees	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 $20\cos30 = 3a$ $a = 5.77$ ms^{-2}	M1 M1 A1 [3]	Resolves 20 (accept 20 sin30) Uses N2L horizontally, accept g in ma term
(ii)	 $R = 3 \times 9.8 + 20 \sin 30 \ (= 39.4)$ $F = 20\cos 30 \ (= 17.3)$ $17.3 = 39.4\mu$ $\mu = 0.44$	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 $s= ut - 0.4t^2/2$ And A1 for PQ=8.4

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

3 (i)	$5\cos30$ or $5\sin60$ or 4.33	B1	Order immaterial, accept +/-. May be awarded
	$5\cos60$ or $5\sin30$ 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]	