

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)	$T = 400 \text{ N}$ $D = 400 + 900$ $= 1300 \text{ N}$	B1 M1 A1 [3]	Order immaterial Or $T + 900$; sign correct
(ii)	$500x0.6 = T - 400$ $T = 700 \text{ N}$ $1250x0.6 = D - 900 - 700$ $D = 2350 \text{ N}$ <i>OR</i> $(500 + 1250)x0.6 = D - 400 - 900$ $D = 2350 \text{ N}$	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)	$5\cos 30$ or $5 \sin 60$ or 4.33 $5\cos 60$ or $5\sin 30$ 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 $9 - 2.5 (= 6.5)$ $R^2 = 2.67^2 + 6.5^2$ $R = 7.03$ $\tan\theta = 6.5/2.67$ $\theta = 67.6, 67.7\text{degrees}$	M1* A1 D*M 1 A1 D*M 1 A1 [6]	Subtracts either component from either force 3sf or better Valid trig for correct angle 3sf or better
4 (i)	$20\cos 30$ $20\cos 30 = 3a$ $a = 5.77 \text{ ms}^{-2}$	M1 M1 A1 [3]	Resolves 20 (accept $20 \sin 30$) Uses N2L horizontally, accept g in ma term
(ii)	$R = 3x9.8 + 20 \sin 30 (= 39.4)$ $F = 20\cos 30 (= 17.3)$ $17.3 = 39.4\mu$ $\mu = 0.44$	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 $F = \mu R$

5 (i)	$V = \int 0.8t dt$ $v = 0.8t^2 / 2 (+c)$ $t = 0, v = 13, (c = 13)$ $v = 0.4x 6^2 (+c)$ $v = 27.4 \text{ ms}^{-1}$	M1* A1 M1 D*M1 A1 [5]	Attempt at integration Award if c omitted
(ii)	$s = \int 0.4t^2 (+c) dt$ $s = 0.4t^3/3 + 13t (+k)$ $t=0, s=0, (k=0)$ $s = 0. 4x6^3/3 + 13x6$ $s = 106.8 \text{ m}$	M1* A1ft M1 D*M1 A1 [5]	Attempt at integration of v(t) ft cv(v(t) in (i)) Allow if k=0 assumed. Accept 107 m.
(iii)	Fig. 2 Fig.1 has zero initial velocity/gradient Fig. 3 does not have a increasing velocity/gradient	B1 [1] B1 B1 [2]	
6 (i) a b	$2.5 = 9.8t^2/2$ $t = 0. 714 \text{ s or better or } 5/7$ $v^2 = 2x9.8x2.5 \text{ OR } v = 9.8 x 0.714$ $v = 7 \text{ ms}^{-1} \text{ or } 6.99 \text{ or art } 7.00$	M1 A1 [2] M1 A1 [2]	Uses $s = 0 +/- gt^2/2$ Not awarded if - sign "lost" Uses $v^2 = 0 +/- 2gs$ or $v = u +/- gt$ Not awarded if - sign "lost"
(ii)	$R = 2x9.8\sin60 (= 16.97 = 17)$ $F = 0.2x16.97 (=3.395 \text{ or } 3.4)$ $\text{Cmpt weight} = 2x9.8\cos60 (= 9.8)$ $2a = 9.8 - 3.395$ $a = 3.2 \text{ ms}^{-2}$ $\text{Distance down ramp} = 5 \text{ m}$ $v^2 = 2x3.2x5$ $v = 5.66 \text{ or } 5.7$	B1 M1 A1ft B1 M1 A1ft B1 M1 A1ft [9]	With incorrect angle, e.g $R = 2x9.8\cos60 (=9.8)$ B0 $F = 0.2x9.8 (=1.96)$ M1A1√ $\text{Cmpt wt} = 2x9.8\sin60 (=16.97)$ B0 $2a = 16.97 - 1.96$ M1 $a = 7.5$ A1√ ft cv(R and Cmpt weight) $v^2 = 2x7.5x5$ $v = 8.66 \text{ or } 8.7$ A1√ ft cv(√(10a))
7 (i)	$p = 4 - 2x0.4 (= 3.2)$ $q = 1 - 2x0.4 (= 0.2)$ $0.7x3.2 - 0.3x0.2 = (1x)v$ $v = 2.18 \text{ ms}^{-1}$	M1 A1 A1 M1 A1 A1 [6]	Use of $v = u - 0.4t$ Accept $q = -0.2$ from $-1+2*0.4$ Uses CoLM on reduced velocities

(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,
b $0 = 1 - 0.4t$ $t = 2.5 \text{ s}$ $P = 4x3 - 0.5x0.4x3^2$ $Q = 1x2.5 - 0.5x0.4x2.5^2$ $PQ = 10.2 + 1.25 = 11.45 \text{ m}$		B1	and gets to t axis before other line ends.
		[3]	SR if t=2 in ii give B1 if line stops before axis
		M1	Finds when Q comes to rest (any method)
		A1	
		M1	Uses $s = ut - 0.4t^2/2$
		A1	
		A1	(nb $0^{(2)} = 1^{(2)} - 0.4Q^2/2$ B1; convincing 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)
		A1	SR if t=2 in iib, allow M1 for $s = ut - 0.4t^2/2$ And A1 for $PQ=8.4$
	[6]		

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

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