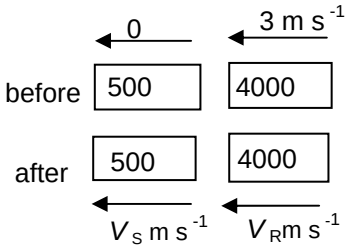
4762 Mechanics 2

Q1		Mark	Comment	Sub
(a) (i)	**either** In direction of the force $I = Ft = mv$ so $1500 \times 8 = 4000v$ giving $v = 3$ so 3 m s^{-1} **or** N2L gives $a = \frac{1500}{4000}$ $v = 0 + \frac{1500}{4000} \times 8$ giving $v = 3$ so 3 m s^{-1}	 M1 A1 A1 M1 A1 A1	 Use of $Ft = mv$ Appropriate use of N2L **and** *uvast*	3
(ii)	 PCLM $12000 = 4000V_R + 500V_S$ so $24 = 8V_R + V_S$ NEL $\frac{V_S - V_R}{0 - 3} = -0.2$ so $V_S - V_R = 0.6$ Solving $V_R = 2.6,\ V_S = 3.2$ so ram 2.6 m s^{-1} and stone 3.2 m s^{-1}	 M1 A1 M1 A1 A1 F1	 Appropriate use of PCLM Any form Appropriate use of NEL Any form Either value	6
(iii)	$0.5 \times 4000 \times 3^2 - 0.5 \times 4000 \times 2.6^2 - 0.5 \times 500 \times 3.2^2$ = 1920 J	M1 B1 A1	Change in KE. Accept two terms Any relevant KE term correct (FT their speeds) cao	3
(b)	see over			

1		Mark	Comment	Sub
(b) (i)	72**i** N s $8(9\cos 60\mathbf{i} + 9\sin 60\mathbf{j})$ = ($36\mathbf{i} + 36\sqrt{3}\mathbf{j}$) N s	B1 E1	Neglect units but must include direction Evidence of use of 8 kg , 9 m s^{-1} and 60°	2
(ii)	$72\mathbf{i} + (36\mathbf{i} + 36\sqrt{3}\mathbf{j}) = 12(u\mathbf{i} + v\mathbf{j})$ Equating components 72 + 36 = 12*u* so *u* = 9 $36\sqrt{3} = 12v$ so $v = 3\sqrt{3}$	M1 M1 A1	PCLM. Must be momenta both sides Both	3
(iii)	**either** $4\times 18 = 8\times 9$ so equal momenta so 60/2 = 30° **or** $\arctan\left(3\sqrt{3}/9\right) = \arctan\left(1/\sqrt{3}\right) = 30°$	M1 A1 M1 A1	Must be clear statements cao FT **their** *u* and *v*. cao	2
		19		

Q 2		Mark	Comment	Sub
(i) (A)	$0.5\times 80\times 3^2 = 360$ J	M1 A1	Use of KE	2
(B)	$360 = F\times 12$ so *F* = 30 so 30 N	M1 F1	*W* = *Fd* attempted FT **their** WD	2
(ii)	Using the WE equation $0.5\times 80\times 10^2 - 0.5\times 80\times 4^2$ $= 80\times 9.8\times h - 1600$ *h* = 6.32653… so 6.33 (3 s. f.)	M1 M1 B1 A1 A1	Attempt to use the WE equation. Condone one missing term Δ KE attempted 1600 with correct sign All terms present and correct (neglect signs) cao	5
(iii) (A)	We have driving force *F* = 40 so 200 = 40*v* and *v* = 5 so 5 m s^{-1}	B1 M1 A1	May be implied Use of *P* = *Fv*	3
(B)	From N2L, force required to give accn is $F - 40 = 80\times 2$ so *F* = 200 *P* = 200×0.5 = 100 so 100 W	M1 A1 A1 M1 A1	Use of N2L with all terms present (neglect signs) All terms correct correct use of P = Fv cao	5
		17		

Q 3		Mark	Comment	Sub
(i)	For $\bar{z}$ $(2\times20\times100+2\times50\times120)\bar{z}$ $=2\times2000\times50+2\times6000\times60$ so $\bar{z}$ = 57.5 and $\bar{y}$ = 0	M1 B1 B1 A1 B1	Method for c.m. Total mass of 16000 (or equivalent) At least one term correct NB This result is given below. NB This result is given below. Statement (or proof) required. N.B. If incorrect axes specified, award max 4/5	5
(ii)	$\bar{y}$ and $\bar{z}$ are not changed with the folding For $\bar{x}$ $100\times120\times0+2\times20\times100\times10=16000\bar{x}$ so $\bar{x}=\frac{40000}{16000}=2.5$	E1 M1 B1 E1	A statement, calculation or diagram required. Method for the c.m. with the folding Use of the 10 Clearly shown	4
(iii)	Moments about AH. Normal reaction acts through this line c.w. $P\times120-72\times(20-2.5)=0$ so P = 10.5	M1 B1 B1 A1 A1	 May be implied by diagram or statement $20-2.5$ or equivalent All correct cao	5
(iv)	$F_{max}=\mu R$ so $F_{max}=72\mu$ For slipping before tipping we require $72\mu<10.5$ so $\mu<0.1458333...$ $(\frac{7}{48})$	M1 A1 M1 A1	Allow $F=\mu R$ Must have clear indication that this is max F Accept $\leq$. Accept **their** F_{max} and R. cao	4
		18		

Q 4		Mark	Comment	Sub
(i)	Centre of CE is 0.5 m from D a.c. moment about D $2200 \times 0.5 = 1100$ so 1100 N m c.w moments about D $R \times 2.75 - 1100 = 0$ R = 400 so 400 N	B1 M1 E1 M1 B1 A1	Used below correctly Use of **their** 0.5 0.5 must be clearly established. Use of moments about D in an equation Use of 1100 and 2.75 or equiv	6
(ii)	c.w moments about D $W \times 1.5 - 1100 - 440 \times 2.75 = 0$ so W = 1540	M1 A1 E1	Moments of all relevant forces attempted All correct Some working shown	3
(iii) (A)	c.w. moments about D $1.5 \times 1540 \cos 20 - 1.75T$ $-1100 \cos 20 - 400 \times 2.75 \cos 20 = 0$ T = 59.0663… so 59.1 N (3 s. f.)	M1 M1 A1 B1 A1 A1	Moments equation. Allow one missing term; there must be some attempt at resolution. At least one res attempt with correct length Allow sin $\leftrightarrow$ cos Any two of the terms have cos 20 correctly used (or equiv) 1.75 T All correct cao Accept no direction given	6
(iii) (B)	**either** Angle required is at 70° to the normal to CE so $T_1 \cos 70 = 59.0663...$ so $T_1 = 172.698...$ so 173 N (3 s.f.) **or** $400 \cos 20 \times 2.75 + 1100 \cos 20$ $= 1540 \cos 20 \times 1.5 - T \sin 20 \times 1.75$ T = 172.698… so 173 N (3s.f.)	B1 M1 A1 M1 A1 A1	 FT (iii) (A) Moments attempted with all terms present All correct (neglect signs) FT(iii)(A)	3
		18		