Question Number	Scheme	Marks
1(a)	$m.5u - kmu = -\frac{m.5u}{2} + \frac{km.u}{2}$ $k = 5$	M1 A1 A1 (3)
(b)	For $P: I = m\left(\frac{5u}{2} - -5u\right)$ OR For $Q: I = km\left(\frac{u}{2} - -u\right)$ $= \frac{15mu}{2}$ $= \frac{15mu}{2}$	M1 A1 A1 (3) **6**
	Notes	
1(a)	M1 for attempt at CLM equation, with correct no. of terms, dimensionally correct. Allow consistent extra g's and cancelled m's and u's and sign errors. First A1 for a correct equation with or without m's and u's Second A1 for $k = 5$ **N.B.** They may find the impulse on each particle and then equate the impulses to produce an equation. Apply the scheme to this equation.	
1(b)	M1 for attempt at impulse = difference in momenta, for either particle, (must be considering *one* particle) (M0 if g's are included or if m or u omitted) Allow $\pm m(\frac{5}{2}u - 5u)$ or $\pm km(\frac{1}{2}u - u)$. First A1 for $\pm m(\frac{5}{2}u - -5u)$ or $\pm km(\frac{1}{2}u - -u)$ A1 for $7.5mu$ oe cao ($-7.5mu$ is A0) Allow change of sign at end to obtain magnitude	

Question Number	Scheme	Marks
2(a)	$0^2 = 19.6^2 - 2 \times gH$ $H = 19.6\text{m}\ (20)$	M1 A1 (2)
(b)	$14.7 = 19.6t - \frac{1}{2}gt^2$ $t^2 - 4t + 3 = 0$ $(t-1)(t-3) = 0$ $t = 1$ or 3; Answer 2 s	M1 A1 **DM**1 A1; A1 (5) **7**
2(b) **ALT 1**	(their h - 14.7) = ½ g t^2 **OR** $v^2 = 19.6^2 - 2g \times 14.7 \Rightarrow v = (\pm)\ 9.8$ t =1 and 0 9.8 – 9.8 t => t = 1 Total = 2 x their 1 = 2 s	M1 A1 A1 **DM** 1 A1
2(b) **ALT 2/3**	$v^2 = 19.6^2 - 2g \times 14.7$ $v = \pm 9.8$ **EITHER:** $-9.8 = 9.8 - gT$ $T = 2$ **OR:** $0 = 9.8t - \frac{1}{2} g t^2$ $t = (0)$ or 2	M1 A1 **DM**1 A1 A1 **DM**1 A1 A1
	Notes	
2(a)	M1 is for a complete method (which could involve use of two *suvat* equations) for finding H i.e. for an equation in H *only*, condone sign errors A1 for 19.6 or 20 <u>correctly obtained</u> (2g is A0)	
2(b)	First M1 is for a quadratic equation in t only (where t is time at 14.7 above O) First A1 for a correct equation Second DM1, dependent on first M1, for solving for t Second A1 for <u>both</u> values of t , 1 and 3. **N.B**. If answer(s) are wrong or have come from an incorrect quadratic, and the quadratic formula has been used, M1 can only be awarded if there is clear evidence that the correct formula has been used. If their expression is not correct for their quadratic, allow a slip but only if <u>we see an attempt to substitute into a stated correct formula.</u> Third A1 for 2 s **N.B.** Obtaining t = 1 at s = 14.7 (above O) only, can score max M1 A1	

Question Number	Scheme	Marks
3	$T_P \cos 55 = T_Q \cos 35$ $T_P \sin 55 + T_Q \sin 35 = 2g$ Eliminating T_P or T_Q $T_P = 16\text{N or } 16.1\text{N};\ T_Q = 11\text{N or } 11.2\text{N}$	M1 A1 M1 A1 M1 A1 A1 **7**
ALT 1	$\left(\text{Along } RP\right)\ T_P = 2g\cos 35° = 16\text{N or } 16.1\text{N}$ $\left(\text{Along } RQ\right)\ T_Q = 2g\cos 55° = 11\text{N or } 11.2\text{N}$	M1 M1 A1 A1 M1 A1 A1
	Notes	
	First M1 for resolving horizontally with correct no. of terms and both T_P and T_Q terms resolved. (M0 if they assume $T_P = T_Q$) First A1 for a correct equation. Second M1 for resolving vertically with correct no. of terms and both T_P and T_Q terms resolved. (M0 if they assume $T_P = T_Q$) Second A1 for a correct equation. Third M1 (independent) for eliminating either T_P or T_Q Third A1 for T_P = 16 (N) or 16.1 (N) Fourth A1 for T_Q = 11 (N) or 11.2 (N) N.B. If both are given to more than 3SF, deduct the third A1.	
ALT 1	**Alternative 1 (resolving along each string)** First M2 for resolving along one of the strings (e.g. $T_P = 2g\cos 35^o$) First A1 for a correct equation ($T_P = 2g\sin 35^o$ scores M2A0A0) Third A1 for T_P = 16 (N) or 16.1 (N) Third M1 for resolving along the other string (e.g. $T_Q = 2g\cos 55^o$) Second A1 for a correct equation ($T_Q = 2g\sin 55^o$ scores M1A0A0) Fourth A1 for T_Q = 11 (N) or 11.2 (N)	
ALT 2	**Alternative 2 (using a Triangle of Forces)** Both of the equations in Alternative 1 could come from using *sohcahtoa* or The Sine Rule on a triangle of forces, so mark in the same way. Note that, in either case, once they have found either T_P or T_Q , they could then use $T_P = T_Q \tan 55^o$ or $T_Q = T_P \tan 55^o$ to find the other one. (Note that both of these are equivalent to the horizontal resolution) or Pythagoras. e.g. $T_P = 2g\cos 35^o$ M2 First A1 = 16 (N) or 16.1 (N) Third A1 $T_Q = T_P \tan 35^o$ or $\sqrt{\{(2g)^2 - (T_P)^2\}}$ M1 Second A1 = 11 (N) or 11.2 (N) Fourth A1	

	N.B. If they are clearly using The Sine Rule but have say 35^o, 55^o and 80^o in their triangle, all 3 M marks would be available and at most 1 A mark e.g. $T_P = \frac{2g\sin 55}{\sin 80}$ M2 A0A0 $T_Q = \frac{T_P \sin 35}{\sin 55}$ M1 SecondA1 A0	

Question Number	Scheme	Marks
4(a)	For crate, $55g - 473 = 55a$ $a = 1.2 \text{m s}^{-2}$	M1 A1 A1 (3)
(b)	For system, $55g + 200g \pm T - 150 = 255a$ M agnitude $= 2040$ N or 2000 N OR For lift, $200g + 473 - 150 \pm T = 200a$ M agnitude = 2040 N or 2000 N	M1 A2 A1 M1 A2 A1 (4) **7**
	Notes	
4(a)	M1 for an equation in a only, with usual rules. First A1 for a correct equation Second A1 for 1.2 (m s^{-2}). Allow – 1.2 (m s^{-2}) if appropriate	
4(b)	M1 for an equation, in T and a , for the system or the lift only, with usual rules. (a does not need to be a numerical value) A2 (-1 each error) for a correct equation (**Allow** ± T). We do **not** need to see a numerical value for a. Third A1 for 2040 (N) or 2000 (N) **N.B.** In both parts of this question use the mass which is being used to guide you as to which part of the system is being considered.	

Question Number	Scheme	Marks
5(a)	$T_A + T_C = 85g$ OR $M(A),\ 25g \times 2.5 + 60g \times 5 = 4.5 \times T_C$ OR $M(C),\ T_A \times 4.5 + 60g \times 0.5 = 25g \times 2$ OR $M(B),\ T_A \times 5 + T_C \times 0.5 = 25g \times 2.5$ OR $M(G),\ T_A \times 2.5 + 60g \times 2.5 = 2 \times T_C$ $T_A = \frac{40g}{9} = 44\text{N or } 43.6\text{N};\ T_C = \frac{725g}{9} = 790\text{N or } 789\text{ N}$	M1 A1 M1 A1 A1; A1 (6)
(b)	$M(C),\ 25g \times 2 = Mg \times 0.5$	M1 A1
(i)	$M = 100$	A1
(ii)	$T_c = 25g + 100g$ $T_c = 125g\ (1200 \text{ or } 1230)\text{N}$	M1 A1 B1 (6) **12**
	Notes	
5(a)	First M1 for a moments or vertical resolution equation, with correct no. of terms and dimensionally correct. First A1 for a correct equation. Second M1 for a moments equation, with correct no. of terms and dimensionally correct. Second A1 for a correct equation. Third A1 for 44 (N) or 43.6 (N) or 40g/9 Fourth A1 for 790 (N) or 789 (N) or 725g/9 Deduct 1 mark for inexact multiples of *g* **N.B.** If they assume that both tensions are the same, can only score max M1 in (a) for *M(A)* or *M(C)*. If a vertical resolution is used, please give marks for this equation FIRST. If not, enter marks for each moments equation in the order in which they appear.	
5(b)	**SCHEME CHANGE** B1 BECOMES THE FOURTH A1 First M1 for a moments equation with $T_A = 0$ First A1 for a correct equation Second A1 for $M = 100$ Second M1 for a(nother) moments or vertical resolution equation with $T_A = 0$ Third A1 for a correct equation Fourth A1 (B1) for $T_C = 125g$ or 1230 (N) or 1200 (N) *N.B. Some candidates may need to solve 2 simult. equations in M and T_C and so will earn the 'equation' marks before they earn Second and Fourth A (B) marks.* If a vertical resolution is used, please give marks for this equation SECOND. If not, enter marks for each moments equation in the order	

	in which they appear. The possible equations are: $T_C = 25g + Mg$ M(C), $25g$ x 2 = Mg x 0.5 M(A), $25g$ x 2.5 + $5Mg$ = 4.5 T_C M(B), $25g$ x 2.5 = T_C x 0.5 M(G), T_C x 2 = Mg x 2.5 Any two of these can each earn M1A1 (M0 if incorrect no. of terms) Then Second A1 for $M = 100$ And Fourth A1 (B1) for T_C = 125g or 1230 or 1200 **N.B.** No marks in (b) if they use any answers from (a) or $M = 60$	

Question Number	Scheme	Marks
6(a)	$\mathbf{r} = (-3\mathbf{i} + 4\mathbf{j})$ m	B1 (1)
(b)	$3.4 = 2T - 3$ or $-12 = 4 - 5T$ $T = 3.2$	M1 A1 A1 (3)
(c)	$\mathbf{r} = (-3\mathbf{i} + 4\mathbf{j}) + t(2\mathbf{i} - 5\mathbf{j})$ $\mathbf{v} = (2\mathbf{i} - 5\mathbf{j})$ speed $= \sqrt{\left(2^2 + (-5)^2\right)} = \sqrt{29} = 5.4\text{m s}^{-1}$ or better	M1 A1 M1 A1 (4) **8**
Alt (c)	$\lvert\mathbf{s}\rvert = \sqrt{6.4^2 + (-16)^2} = 17.23...$ $\therefore$ speed $= \dfrac{17.23}{3.2} = 5.4$ or better	M1 A1 M1 A1 (4)
	Notes	
6(a)	**Allow column vectors throughout.** B1 for $(-3\mathbf{i} + 4\mathbf{j})$ (m)	
(b)	M1 for a clear attempt at either 3.4 (**i**)= $(2T - 3)$ (**i**) or -12(**j**) = $(4 - 5T)$ (**j**) First A1 for a correct equation (either) without **i**'s and **j**'s A1 for 3.2 oe **N.B.** $T = \dfrac{6.4\mathbf{i} - 16\mathbf{j}}{2\mathbf{i} - 5\mathbf{j}} = 3.2$ scores M1A1A1 BUT if RHS is not a single number, then M0. Also, if they get 3.2 and another value and don't clearly choose 3.2 then A0	
(c)	First M1 for a complete method for finding **v** e.g. $\mathbf{r} = (-3\mathbf{i} + 4\mathbf{j}) + t(2\mathbf{i} - 5\mathbf{j})$ so **v** = 2**i** – 5**j** OR: $\mathbf{v} = \dfrac{(3.4\mathbf{i} - 12\mathbf{j}) - (-3\mathbf{i} + 4\mathbf{j})}{\text{their } T}$ OR: $\mathbf{v} = \dfrac{\mathrm{d}\mathbf{r}}{\mathrm{d}t} = 2\mathbf{i} - 5\mathbf{j}$ First A1 for $2\mathbf{i} - 5\mathbf{j}$; M1A1 can be awarded for $2\mathbf{i} - 5\mathbf{j}$ only. Second M1 for attempt to find magnitude of their **v**, i.e. $\sqrt{2^2 + (-5)^2}$ Second A1 for √29 or 5.4 or better **OR** First M1 for attempt to find distance travelled: $d = \sqrt{(-3 - 3.4)^2 + (4 - -12)^2}$ First A1 if correct Second M1 for their d / their T Second A1 for √29 or 5.4 or better	

Question Number	Scheme	Marks
7(a)		B1 (shape) B1 (V) (2)
(b) **(i) (ii)**	$\frac{V}{t_1}=\frac{1}{2} \Rightarrow t_1=2V$ s; $t_2=4V$ s	M1 A1; A1
(iii)	$t_3=300-2V-4V=300-6V$ s	M1 A1 (5)
(c)	$6300=\frac{V(300+300-6V)}{2}$ or $\frac{1}{2}2V.V+(300-6V).V+\frac{1}{2}4V.V$ $V^2-100V+2100=0$ $(V-30)(V-70)=0$ $V=30$ or 70 $V=30\ (<50)$	M1 **A1 ft** A1 M1 A1 A1 (6) **13**
	Notes	
7(a)	B1 for a trapezium with line starting and finishing on the t-axis B1 for V correctly marked	
(b)	First M1 for a correct method First A1 for $V/0.5$ oe Second A1 for $V/0.25$ oe Second M1 for (300 – sum of previous answers) Allow 5 instead of 300. Third A1 for $300-6V$ oe	
(c)	First M1 for using the area under the curve (distance travelled) to form an equation in V only. (Allow use of 6.3 but must see ½ used at least once in their expression.) First A1 **ft on their answers in (b)** for a correct equation so must have used 6300 not 6.3 Second A1 for correct equation in form $aV^2+bV+c=0$ Second M1 for solving a 3 term quadratic. (Can be implied by correct answers) Second A1 for either 30 or 70	

	Third A1 for 30 as final answer. **N.B**. If answer(s) are wrong or have come from an incorrect quadratic, and the quadratic formula is used, M1 can only be awarded if there is clear evidence that the correct formula has been used. i.e. we need to see numbers substituted into a stated correct formula.	

Question Number	Scheme	Marks
8(a)	$R = 4g\cos\alpha$	M1 A1
	$T - 0.5g = 0.5a$	M1 A1
	$4g\sin\alpha - T - F = 4a$	M1 A1
	(OR: $4g\sin\alpha - F - 0.5g = 4.5a$)	
	$F = \frac{1}{2}R$; $\sin\alpha = \frac{4}{5}$ or $\cos\alpha = \frac{3}{5}$	B1; B1
	Eliminating a or finding a	M1
	Solving for T (must have had an a)	M1
	$T = \frac{2g}{3}$ N or 6.5N or 6.53N	A1
		(11)
(b)	Magnitude $= 2T\cos\left(\frac{90-\alpha}{2}\right)$	M1 A1
	$= 2 \text{ x } \frac{2g}{3} \text{ x } \frac{3}{\sqrt{10}}$ (0.94868..)	**A1 ft on *T***
	$= 12N$ or $12.4N$ $\left(\frac{4g}{\sqrt{10}}\right)$	A1 (4)
		15
	Notes	
8(a)	First M1 for resolving perp to plane, with usual criteria First A1 for a correct equation Second M1 for resolving vertically, with usual criteria Second A1 for a correct equation, in terms of a and T Third M1 for resolving parallel to the slope, with usual criteria. Third A1 for a correct equation , in terms of a, F and T N.B. Their a could be UP the slope in which case all 4 marks for the 2 equations are available with $-a$ replacing a, provided they are consistent. If they are inconsistent, then assume the vertical resolution is the correct one and mark accordingly. Either of the above two equations can be replaced by the 'whole system' equation **N.B. If they use a = 0, in any of the above 3 equations, and they use the equation to find T, they lose both marks for that equation, and they lose the two M marks for eliminating and solving.** First B1 for $F = \frac{1}{2}R$ seen or implied; Second B1 for $\sin\alpha = 0.8$ or $\cos\alpha = 0.6$ seen or implied. Allow close approximations if $\alpha = 53.1^{\circ}\ldots$ used. Fourth M1 independent for eliminating a or finding a. Fifth M1 for solving for T but must have had an a. Fourth A1 for 2g/3, 6.5 or 6.53.	

(b)	First M1 for a complete method for finding the magnitude of the resultant (**N.B.** M0 if same tensions used) $2T\cos\left(\frac{90^\circ-\alpha}{2}\right)$ .Allow sin/cos confusion and allow $2T\cos\left(\frac{\alpha}{2}\right)$ **OR** $\sqrt{(T+T\sin\alpha)^2+(T\cos\alpha)^2}$. Allow sin/cos confusion and allow omission of √ sign, but only if R^2 = ……. is included **OR** $\sqrt{T^2+T^2-2T^2\cos(90^\circ+\alpha)}$**.** Allow $(90^\circ-\alpha)$ but must be cos and and allow omission of √ sign, but only if R^2 =…….is included **OR** $\frac{T\sin(90+\alpha)}{\sin\left(\frac{90^\circ-\alpha}{2}\right)}$**. (Sine Rule)** Allow sign errors in angles but must be sin First A1 for correct expression in terms of T and α Second A1, **ft** on their T, for a 'correct' **single numerical** answer Third A1 cao for 12 (N) or 12.4 (N)	