Question	Scheme	Marks	AOs
1(a)	$(3t-1)\mathbf{i}+2\mathbf{j}=0.5\mathbf{a}$	M1	3.1a
	Integrate their **a** wrt t	M1	2.1
	$(3t^2-2t)\mathbf{i}+4t\mathbf{j}$ (+**C**)	A1	1.1b
	Find **C** and substitute in $t = 2$	M1	1.1b
	$9\mathbf{i}+7\mathbf{j}$ (m s^{-1})	A1	1.1b
		(5)	
1(b)	Integrate their **v** wrt t	M1	2.1
	$(t^3-t^2+t)\mathbf{i}+(2t^2-t)\mathbf{j}$ (+**D**)	A1**ft**	1.1b
	Solve problem by putting $t = 2$ and using Pythagoras, with square root	M1	3.1a
	$\sqrt{72}$ oe, 8.5 or better (m)	A1	1.1b
		(4)	
			(9 marks)

Notes: Accept column vectors throughout

1a	M1	Use of **F** = m**a**, with $m = 0.5$ seen or implied
	M1	At least two powers increasing by 1
	A1	Correct vector expression
	M1	Use boundary condition to find **C** and sub in $t = 2$
	A1	cao
1b	M1	At least two powers increasing by 1
	A1**ft**	Follow their **v**
	M1	Putting $t = 2$ into their vector displacement expression and finding the magnitude
	A1	cao

Notes Question 1 (a)

M1: Differentiate $\mathbf{r}_P$ with respect to t to form vector. Evidence of powers being decreased by one on at least two terms and in form $c\mathbf{i} + d\mathbf{j}$

A1: Correct answer

M1: Correct ratio used on their calculated $\mathbf{v}_P$ to form quadratic equation in t

M1: Obtaining a 3 term quadratic and solving for t

A1: $t = 2.5$

(b)

M1: Differentiate $\mathbf{v}_P$ with respect to t

A1: Substitute $t = 2.5$ into $\mathbf{a}_P$ to get correct answer from correct working

(c)

M1: Integrate $\mathbf{v}_Q$ with respect to t to get $\mathbf{r}_Q$. Must be a vector.

A1: Correct vector expression.

M1: Pythagoras must include square root

A1: $\mathrm{d} = \frac{\sqrt{205}}{2} (\mathrm{m})$

Question	Scheme	Marks	AOs
2(a)	Resolve horizontally: $F = S$	B1	3.3
	Resolve vertically: $R = W + 6W$	B1	3.4
	Using $F = \frac{1}{3}R$, solve for S	M1	2.1
	$S = \frac{7}{3}W$	A1	2.2a
		(4)	
(b)	Take moments about A:	M1	3.4
	$6W \times x\cos\theta + W \times a\cos\theta = S \times 2a\sin\theta$	A1	1.1b
	Use $\tan\theta = \frac{12}{5}$ and solve for x	M1	1.1b
	$AC = \frac{17}{10}a$	A1	1.1b
		(4)	
(c)	Assume the ladder does not bend (rigid)	B1	3.5a
	Assume the weight is at the centre of the ladder	B1	3.5a
		(2)	
(d)	Magnitude of normal reaction at B will **decrease**	B1	2.2a
	Frictional force at $B \Rightarrow R$ decreases (resolving vertically) $\Rightarrow$ frictional force at A ($= \frac{1}{3}R$) decreases $\Rightarrow S$ decreases (resolving horizontally) **Or** Frictional force at $B \Rightarrow$ Extra anticlockwise moment in moments about A equation (clockwise moments unchanged) $\Rightarrow$ moment of S decreases $\Rightarrow S$ decreases	B1	2.4
		(2)	
			(12 marks)

Notes Question 2:

(a)

B1: Correct horizontal equation

B1: Correct vertical equation

M1: Uses the two resolution equations and $F=\frac{1}{3}R$ to find a value for S

A1: Correct answer (accept $2.3W$ or more accurate decimal)

(b)

M1: Moments equation with correct number of dimensionally correct terms. Allow sin/cos confusion. Could be about a different point e.g *B*.

A1: Correct equation. Trig ratios do not need to be substituted.

M1: Substitutes trig ratios and solves for *AC*

A1: Correct answer

(c)

B1: Does not bend **or** remains straight **or** rigid **or equivalent**

B1: Weight acts on the midpoint of the ladder

(d)

B1: Correct statement

B1: Correct reasoning

Q3

7(a) (i)	$T - 2mg\sin\alpha - F = 2ma$	M1A1
(ii)	$3mg - T = 3ma$	M1A1
	N.B. Ignore the labelling (i) and (ii)	(4)
7(b)	$R = 2mg\cos\alpha$ Allow if this appears in (a).	M1A1
	$F = \frac{1}{2}R$	B1
	Substitute for trig. and solve for a,	DM1
	$a = \frac{1}{5}g$	A1
		(5)
7(c)	$T = \frac{12mg}{5}$ $(23.52m)$	DM1
	$2T\cos\left(\frac{90^o - \alpha}{2}\right)$ **OR** $\sqrt{T^2 + T^2 - 2T^2\cos(90^o + \alpha)}$ **OR** $\sqrt{(T\cos\alpha)^2 + (T + T\sin\alpha)^2}$	M1
	Substitute for trig and T to obtain an expression in m or mg	DM1
	$\frac{48\sqrt{5}mg}{25}$; Accept $4.3mg$ or better, $42m$ or $42.1m$	A1
		(4)
7(d)	Tension is the same on **either side of the pulley**, tension across the pulley is the same.	B1
	B0 for tension is same for A and B or is the same for both strings etc	(1)
		(14)

	Notes for question 7	
	N.B. If m's are consistently missing, mark (a) and (b) as a MR	
7(a)	M1 Correct no. of terms, condone sin/cos confusion and sign errors	
	A1 Correct equation	
	M1 Correct no. of terms, condone sign errors	
	A1 Correct equation **N.B.** Could have a replaced by $(-a)$ in both	
7(b)	M1 Correct no. of terms, condone sin/cos confusion and sign errors	
	A1 Correct equation	
	B1 Seen, possibly on a diagram or in (a)	
	DM1, dependent on the two M's in (a), for solving 2 simultaneous equations or using a whole system equation to find a	
	A1 cao	
7(c)	DM1, dependent on the relevant 1st or 2nd M1 in (a), for attempt to find their T, must be of form km or kmg. Apply isw if they 'cancel' m's.	
	M1 for a **correct** expression in terms of T and α only; α does not need to be substituted	
	DM1, dependent on previous M, for substituting in their T **and** for trig, to give an expression of form km or kmg	
	A1 cao	
7(d)	B1 for any equivalent statement. B0 for incorrect extras.	

Question	Scheme	Marks	AOs
4 (a)	Horizontal motion: $x = 5t$	B1	3.3
	Vertical motion: $s = ut + \frac{1}{2}at^2$	M1	3.4
	$y = 8t - \frac{1}{2} \times 10 \times t^2$	A1	1.1b
	$y = 1.6x - 0.2x^2$ *	A1*	2.2a
		(4)	
(b)	$0 = 1.6x - 0.2x^2$	M1	1.1b
	$OA = 8$ (m)	A1	1.1b
		(2)	
(c)	$\dot{x} = 5$	B1	3.4
	When $x = 6$, $y = 1.6\times6 - 0.2\times36$ (= 2.4) **OR** When $x = 6$, $t = 6\div5$ (= 1.2)	M1	1.1b
	$\dot{y}^2 = 8^2 - 2\times10\times2.4$ **OR** $\dot{y} = 8 - 10\times1.2$	M1	3.4
	Speed ($= \sqrt{5^2 + (-4)^2}$) = 6.4 (m s^{-1})	A1	1.1b
	Angle (with horizontal) = $\tan^{-1}\left(\frac{4}{5}\right)$	M1	1.1b
	Direction at angle 39° below the horizontal (oe)	A1	2.2a
		(6)	
(d)	It would **increase** the value of OA predicted by the model	B1	2.2a
	Smaller value of g $\Rightarrow$ smaller magnitude of coefficient of x^2 in equation $0 = 1.6x - 0.2x^2 \Rightarrow$ larger value of x	B1	2.4
		(2)	
(e)	Take account of one factor such as • air resistance • spin • wind • size of ball	B1	3.5c
		(1)	
			(15 marks)

Notes Question 4:

(a)

B1: Correct expression for horizontal distance in terms of t

M1: Use of $s = ut + \frac{1}{2}at^2$ using $u = 8$

A1: Correct unsimplified equation

A1*: Eliminates t to reach given answer from fully correct working

(b)

M1: Substitutes $y = 0$ in given equation (must be using part (a))

A1: Correct answer

(c)

B1: Correct horizontal velocity component seen or implied

M1: **Either** finds y when $x = 6$ **or** finds t when $x = 6$

M1: Complete method to find vertical component of velocity (or square of vertical component)

A1: Correct speed (to 2 sig figs as directed by question)

M1: Correct use of trig to find a relevant angle for the direction, using horizontal and vertical velocity components

A1: Correct angle (to 2 sig figs as directed by question, but 'over-accuracy' only penalised once per question), including indication that the direction is downwards (could be on a diagram).

(d)

B1: Correct statement

B1: Correct reasoning

(e)

B1: Any one factor related to the model