Question 1

Question Number	Scheme	Marks
4(a)	Max ht $v = 0$. $v = u - gt \Rightarrow T = \frac{u}{g}$	M1A1 (2)
(b)	Max ht $H = ut + \frac{1}{2}at^2 = \frac{u^2}{g} - \frac{u^2}{2g} = \frac{u^2}{2g}$ * Given answer* Or use of $v^2 = u^2 + 2as$	M1A1 (2)
(c)	$-3 \times \frac{u^2}{2g} = ut - \frac{1}{2}gt^2$ $-3u^2 = 2ugt - g^2t^2$ $g^2t^2 - 2ugt - 3u^2 = 0, \quad gt = \frac{2u \pm \sqrt{4u^2 + 12u^2}}{2}$ $t = \frac{3u}{g} = 3T$	M1 **DM**1 A1 A1 (4)
(c) alt	$-4H = -\frac{1}{2}gt^2$ Total time $= T + \sqrt{\frac{8H}{g}} = T + \sqrt{\frac{8u^2}{2g^2}}$ $= T + 2T = 3T$	M1 **DM**1A1 A1 (4)
		[8]

Notes for Question 4

Question 4

In this question, condone sign errors in a *suvat* equation for the M mark, but a missing term is M0 or an incorrect term is M0. An incorrect *suvat* formula is M0

Allow use of symmetry of motion.

e.g. in (a), using $v = u + at$, *either* $0 = u - gT$ *or* $u = 0 + gT$

Question 4(a)

M1 for use of *suvat* to obtain an equation in T, u and g only.

A1 for $T = u/g$ correctly obtained.

Question 4(b)

M1 for use of *suvat* to obtain an equation in H, u and g only.

A1 for $H = u^2/2g$ correctly obtained **(given answer)**

Question 4(c) *Watch out for t / T confusion* (**N.B**. if only T's used, M0DM0)

First M1 for a complete method to find the *total* time in terms of u, g, H or T:-

either: $3H = -ut + \frac{1}{2}gt^2$

or: $4H = \frac{1}{2}gt^2$ and $t + T$

or: $v^2 = u^2 + 6gH$ and $v = -u + gt$,with v eliminated

Second M1, **dependent on first M1**, for producing an expression, in terms of u, g, H or T, for the total time, by solving a quadratic

First A1 for any correct expression for the total time in terms of u, g, H or T.

Second A1 for $3T$ cso

Question 2

Question Number	Scheme	Marks
2(a)	$R = mg\cos 40$	B1
	Use of $F = \mu R$	B1
	$mg\sin 40 - F = \pm ma$	M1A1
	$acc = 2.55$ (m s^{-2}) or 2.5 (m s^{-2})	A1 (5)
(b)	$v^2 = u^2 + 2as = 2\times a\times 3$ Speed at B is 3.9 (m s^{-1}) or 3.91(m s^{-1})	M1A1 (2)
		[7]

Notes for Question 2

(Deduct only 1 mark in **whole question** for not giving an answer to either 2 sf or 3 sf, following use of g = 9.8)

Question 2(a)

First B1 for $R = mg\cos 40^o$

Second B1 for $F = \mu R$ seen or implied(can be on diagram)

M1 for resolving parallel to plane, correct no. of terms, mg resolved (F does not need to be substituted)

First A1 for a correct equation

Second A1 for 2.5 (ms^{-2}) or 2.55 (ms^{-2}) Must be **positive.**

S.C. If m is given a specific numerical value, can score max B1B1M1A0A0

Question 2(b)

M1 is for a complete method for finding speed (usually $v^2=u^2+2as$)

A1 for 3.9 (ms^{-1}) or 3.91(ms^{-1})

Question 3

Qu 2	Scheme	Marks	AO
(a)	$H_0 : \rho = 0$ $H_1 : \rho < 0$	B1	2.5
	Critical value: -0.6215 (Allow any cv in range $0.5 < \lvert cv \rvert < 0.75$)	M1	1.1a
	$r < -0.6215$ so significant result and there is evidence of a negative correlation between w and t	A1	2.2b
		(3)	
(b)	e.g. As temperature increases people spend more time on the beach and less time shopping (o.e.)	B1	2.4
		(1)	
(c)	Since r is close to -1 , it **is** consistent with the suggestion	B1	2.4
		(1)	
(d)	t will be the explanatory variable since sales are likely to depend on the temperature	B1	2.4
		(1)	
(e)	Every degree rise in temperature leads to a drop in weekly earnings of £171	B1	3.4
		(1)	
		(7 marks)	

	Notes
(a)	B1 for both hypotheses in terms of ρ M1 for the critical value: sight of ± 0.6215 or any cv such that $0.5 < \lvert cv \rvert < 0.75$ A1 must reject H_0 on basis of comparing -0.915 with -0.6215 (if $-0.915 < 0.6215$ is seen then A0 but may use $\lvert r \rvert$ o.e. which is fine) and mention "negative", "correlation/relationship" and at least "w" and "t"
(b)	B1 for a suitable reason to explain negative correlation using the context given. e.g. "As temperature drops people are more likely to go shopping (than to the beach)" e.g. "As temperature increases people will be outside rather than in shops" A mere description in context of negative correlation is B0 SO e.g. "As temperature increases people don't want to go shopping/buy clothes" is B0 e.g. "Less clothes needed as temp increases" is B0
(c)	B1 for a suitable reason e.g. "strong"/"significant"/"near perfect" "correlation", $\lvert r \rvert$ close to 1 and saying it is consistent with the suggestion. Allow "yes" followed by the reason.
(d)	B1 For identifying t and giving a suitable reason. Need idea that "w depends on t" or "w responds to t" or "t affects w" (o.e.) Allow t (temperature) affects the other variable etc Just saying " t is the independent variable" or "t explains change in w" is B0 N. B. Suggesting causation is B0 e.g. "t causes w to decrease"
(e)	B1 for a description that conveys the idea of rate per degree Celsius. Must have 171, condone missing "£" sign.

Question 4

Question	Scheme	Marks	AOs
7(a)	Resolve vertically	M1	3.1b
	$R + 40\sin\alpha = 20g$	A1	1.1b
	Resolve horizontally	M1	3.1b
	$40\cos\alpha - F = 20a$	A1	1.1b
	$F = 0.14R$	B1	1.2
	$a = 0.396$ or 0.40 (m s^{-2})	A1	2.2a
		(6)	
(b)	Pushing will increase R which will increase available F	B1	2.4
	Increasing F will decrease a * GIVEN ANSWER	B1*	2.4
		(2)	
			(8 marks)

Notes:

(a)

M1: Resolve vertically with usual rules applying

A1: Correct equation**.** Neither g nor $\sin\alpha$ need to be substituted

M1: Apply $F = ma$ horizontally, with usual rules

A1: Neither F nor $\cos\alpha$ need to be substituted

B1: $F = 0.14R$ seen (e.g. on a diagram)

A1: Either answer

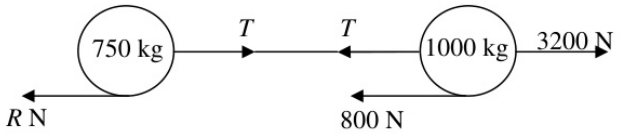
(b)

B1: Pushing increases R which produces an increase in available (limiting) friction

B1: F increase produces an a decrease (need to see this)

N.B. It is possible to score B0 B1 but for the B1, some "explanation" is needed to say why friction is increased e.g. by pushing into the ground.

Question 5

Question Number	Scheme	Marks
2 (a)	 For the whole system R(→) $3200-800-R=1750\times0.88$ Leading to $R=860$ ✱	M1 A1 A1 (3)
(b)	For the caravan R(→) $T-860=750\times0.88$ Leading to $T=1520$ (N)	M1 A1 A1 (3) **6**
	Alternative for (b) For the car R(→) $3200-800-T=1000\times0.88$ Leading to $T=1520$ (N)	M1 A1 A1 (3)

Question 6

Question	Scheme	Marks	AOs
8 (a) **Way 1**	$H = Ax(40-x)$ {or $H = Ax(x-40)$ }	M1	3.3
	$x=20,\ H=12 \Rightarrow 12 = A(20)(40-20) \Rightarrow A = \frac{3}{100}$	dM1	3.1b
	$H = \frac{3}{100}x(40-x)$ or $H = -\frac{3}{100}x(x-40)$	A1	1.1b
		(3)	
(a) **Way 2**	$H = 12-\lambda(x-20)^2$ {or $H = 12+\lambda(x-20)^2$ }	M1	3.3
	$x=40,\ H=0 \Rightarrow 0 = 12-\lambda(40-20)^2 \Rightarrow \lambda = \frac{3}{100}$	dM1	3.1b
	$H = 12-\frac{3}{100}(x-20)^2$	A1	1.1b
		(3)	
(a) **Way 3**	$H = ax^2+bx+c$ (or deduces $H = ax^2+bx$) **Both** $x=0,\ H=0 \Rightarrow 0 = 0+0+c \Rightarrow c=0$ **and either** $x=40,\ H=0 \Rightarrow 0 = 1600a+40b$ **or** $x=20,\ H=12 \Rightarrow 12 = 400a+20b$ **or** $\frac{-b}{2a} = 20$ $\{\Rightarrow b=-40a\}$	M1	3.3
	$b=-40a \Rightarrow 12 = 400a+20(-40a) \Rightarrow a=-0.03$ so $b=-40(-0.03)=1.2$	dM1	3.1b
	$H = -0.03x^2+1.2x$	A1	1.1b
		(3)	
(b)	$\{H=3 \Rightarrow\}\ 3 = \frac{3}{100}x(40-x) \Rightarrow x^2-40x+100=0$ **or** $\{H=3 \Rightarrow\}\ 3 = 12-\frac{3}{100}(x-20)^2 \Rightarrow (x-20)^2 = 300$	M1	3.4
	e.g. $x = \frac{40 \pm \sqrt{1600-4(1)(100)}}{2(1)}$ or $x = 20 \pm \sqrt{300}$	dM1	1.1b
	$\left\{\text{chooses } 20+\sqrt{300} \Rightarrow\right\}$ greatest distance = awrt 37.3 m	A1	3.2a
		(3)	
(c)	Gives a limitation of the model. Accept e.g. • the ground is horizontal • the ball needs to be kicked from the ground • the ball is modelled as a particle • the horizontal bar needs to be modelled as a line • there is no wind or air resistance on the ball • there is no spin on the ball • no obstacles in the trajectory (or path) of the ball • the trajectory of the ball is a perfect parabola	B1	3.5b
		(1)	
			(7 marks)

Notes for Question 8	
(a)	
M1:	Translates the situation given into a suitable equation for the model. E.g. **Way 1:** {Uses $(0,0)$ and $(40,0)$ to write} $H = Ax(40-x)$ o.e. {or $H = Ax(x-40)$ }
	Way 2: {Uses $(20,12)$ to write} $H = 12-\lambda(x-20)^2$ or $H = 12+\lambda(x-20)^2$
	Way 3: Writes $H = ax^2+bx+c$, **and** uses $(0,0)$ to deduce $c=0$ **and** an attempt at using either $(40,0)$ or $(20,12)$ **Special Case:** Allow SC M1dM0A0 for not deducing $c=0$ but attempting to apply both $(40,0)$ and $(20,12)$
dM1:	Applies a complete strategy with appropriate constraints to find all constants in their model. **Way 1:** Uses $(20,12)$ on their model and finds $A=...$ **Way 2:** Uses either $(40,0)$ or $(0,0)$ on their model to find $\lambda=...$ **Way 3:** Uses $(40,0)$ and $(20,12)$ on their model to find $a=...$ and $b=...$
A1:	Finds a correct equation linking H to x E.g. $H=\frac{3}{100}x(40-x)$, $H=12-\frac{3}{100}(x-20)^2$ or $H=-0.03x^2+1.2x$
Note:	Condone writing y in place of H for the M1 and dM1 marks.
Note:	Give final A0 for $y=-0.03x^2+1.2x$
Note:	Give special case M1dM0A0 for writing down any of $H=12-(x-20)^2$ or $H=x(40-x)$ or $H=x(x-40)$
Note:	Give M1 dM1 for finding $-0.03x^2+1.2x$ or $a=-0.03, b=1.2, c=0$ in an implied ax^2+bx or ax^2+bx+c (with no indication of $H=...$)
(b)	
M1:	Substitutes $H=3$ into their quadratic equation and proceeds to obtain a 3TQ or a quadratic in the form $(x\pm\alpha)^2=\beta;\ \alpha,\beta\neq 0$
Note:	E.g. $1.2x-0.03x^2=3$ or $40x-x^2=100$ are acceptable for the 1st M mark
Note:	Give M0 dM0 A0 for (their A)$x^2=3\Rightarrow x=...$ or their (their A)x^2+(their k)$=3\Rightarrow x=...$
dM1:	Correct method of solving their quadratic equation to give ***at least one solution***
A1:	Interprets their solution in the original context by selecting the larger correct value ***and states correct units for their value***. E.g. Accept awrt 37.3 m or $\left(20+\sqrt{300}\right)$ m or $\left(20+10\sqrt{3}\right)$ m
Note:	Condone the use of inequalities for the method marks in part (b)
(c):	
B1:	See scheme
Note:	Give no credit for the following reasons • H (or the height of ball) is negative when $x>40$ • Bounce of the ball should be considered after hitting the ground • Model will not be true for a different rugby ball • Ball may not be kicked in the same way each time

Question 7

Qu 5	Scheme	Marks	AO
(a)	$P(L > 16) = 0.69146\ldots$ **awrt 0.691**	B1 (1)	1.1b
(b)	$P(L > 20 \mid L > 16) = \dfrac{P(L>20)}{P(L>16)}$	M1	3.1b
	$= \dfrac{0.308537...}{(a)}$ or $\dfrac{1-(a)}{(a)}, = 0.44621\ldots$	A1ft, A1	1.1b 1.1b
	For calc to work require $(0.44621...)^4 = 0.03964\ldots$ **awrt <u>0.0396</u>**	dM1 A1 (5)	2.1 1.1b
(c)	Require: $[P(L>4)]^2 \times [P(L>20 \mid L>16)]^2$	M1	1.1a
	$= (0.99976...)^2 \times ("0.44621...")^2$	A1ft	1.1b
	$= 0.19901\ldots$ **awrt <u>0.199</u> (*)**	A1cso* (3)	1.1b
(d)	$H_0 : \mu = 18 \quad H_1 : \mu > 18$	B1	2.5
	$\bar{L} \sim N\left(18, \left(\dfrac{4}{\sqrt{20}}\right)^2\right)$	M1	3.3
	$P(\bar{L} > 19.2) = P(Z > 1.3416\ldots) = 0.089856\ldots$	A1	3.4
	(0.0899 > 5%) <u>or</u> (19.2 < 19.5) <u>or</u> 1.34 < 1.6449 so not significant	A1	1.1b
	Insufficient evidence to support Alice's claim (or belief)	A1 (5)	3.5a
		(14 marks)	

	Notes
(a)	B1 for evaluating probability using their calculator (awrt 0.691) Accept 0.6915
(b)	1st M1 for a first step of identifying a suitable conditional probability (either form) 1st A1ft for a ratio of probabilities with numerator = awrt 0.309 or 1 – (a) and denom = their (a) 2nd A1 for awrt 0.446 (o.e.) Accept 0.4465 (from $\frac{0.3085}{0.691} = 0.44645...$) NB $\frac{P(16<L<20)}{P(L>16)} = 0.5538\ldots$ scores M1A1A1 when they do 1 – 0.5538 = 0.4462… 2nd M1 (dep on 1st M1) for 2nd correct step i.e. (their 0.446…)^4 <u>or</u> X~B(4, "0.446") and P(X = 4) 3rd A1 for awrt 0.0396
(c)	1st M1 for a correct approach to solving the problem (May be implied by A1ft) 1st A1ft for P(L > 4) = awrt 0.9998 used <u>and</u> ft their 0.44621 in correct expression If use P(L > 20) = 0.3085.. as 0.446.. in (b) then M1 for $(0.3085..)^2 \times [P(L>4)]^2$; A1ft as above * 2nd A1cso for 0.199 or better with clear evidence of M1 [NB $(0.4662..)^2 = 0.199\ldots$ is M0A0A0] **Must see M1 scored by correct expression in symbols or values (M1A1ft)**
(d)	B1 for both hypotheses in terms of μ. M1 for selecting a suitable model. Sight of <u>normal</u>, <u>mean</u> 18, <u>sd</u> $\frac{4}{\sqrt{20}}$ (o.e.) or <u>variance</u> = 0.8 1st A1 for using the model correctly. Allow awrt 0.0899 <u>or</u> 0.09 from correct prob. statement **ALT** **CR** $(\bar{L}) > 19.471\ldots$ (accept awrt 19.5) <u>or</u> **CV** of 1.6449 (or better: calc 1.6448536..) 2nd A1 for correct non-contextual conclusion. Wrong comparison or contradictions A0 Error giving 2nd A0 implies 3rd A0 but just a correct contextual conclusion can score A1A1 3rd A1 dep on M1 and 1st A1 for a correct contextual conclusion mentioning <u>Alice's claim</u> /<u>belief</u> <u>or</u> there is insufficient evidence that the mean <u>lifetime</u> is more than 18 hours

Question 8

Paper 3: Statistics and Mechanics Mark Scheme

Question	Scheme	Marks	AOs
1(a)	**Area** = $8\times1.5=12$ cm^2 **Frequency** = 8 so 1 cm^2 = $\frac{2}{3}$ **hour (o.e.)**	M1	3.1a
	Frequency of 12 corresponds to area of 18 so height = $18\div2.5$ = **7.2 (cm)**	A1	1.1b
	Width = 5×0.5 = **2.5 (cm)**	B1cao	1.1b
		(3)	
(b)	$[\bar{y}=]\ \frac{205.5}{31}=$ awrt 6.63	B1cao	1.1b
	$[\sigma_y=]\ \sqrt{\frac{1785.25}{31}-\bar{y}^2}\ =\sqrt{13.644641}$ **= awrt 3.69** allow $[s=]\ \sqrt{\frac{1785.25-31\bar{y}^2}{30}}$ **= awrt 3.75**	M1 A1	1.1a 1.1b
		(3)	
(c)	Mean of Heathrow is higher than Hurn and standard deviation smaller suggesting Heathrow is more reliable	M1	2.4
	Hurn is South of Heathrow so does <u>not</u> support his belief	A1	2.2b
		(2)	
(d)	$\bar{x}+\sigma\approx10.3$ so number of days is e.g. $\frac{(11-"10.3")}{3}\times8\ (+5)$	M1	1.1b
	= 6.86 so **7 days**	A1	1.1b
		(2)	
(e)	[H = no. of hours] P($H>10.3$) or P($Z>1$) = [0.15865…]	M1	3.4
	Predict $31\times0.15865...$ = **<u>4.9 or 5 days</u>**	A1	1.1b
		(2)	
(f)	(5 or) 4.9 days < (7 or) 6.9 days so model may **not** be suitable	B1	3.5a
		(1)	
			(13 marks)

Question 1 continued

Notes:

(a)

M1: for clear attempt to relate the area to frequency. Can also award if their height × their width = 18

A1: for height = 7.2 (cm)

(b)

M1: for a correct expression for σ or s, can ft their value for mean

A1: awrt 3.69 (allow s = 3.75)

(c)

M1: for a suitable comparison of standard deviations to comment on reliability.

A1: for stating Hurn is south of Heathrow and a correct conclusion

(d)

M1: for a correct expression – ft their $\bar{x}+\sigma\approx10.3$

A1: for 7 days but accept 6 (rounding down) following a correct expression

(e)

M1: for a correct probability attempted

A1:	for a correct prediction
(f) **B1:**	for a suitable comparison and a compatible conclusion

Question 9

Question	Scheme	Marks	AOs
2(a)	e.g. It requires extrapolation so will be unreliable (o.e.)	B1	1.2
		(1)	
(b)	e.g. Linear association between w and t	B1	1.2
		(1)	
(c)	H_0: $\rho = 0$ H_1: $\rho > 0$	B1	2.5
	Critical value 0.5822	M1	1.1a
	Reject H_0		
	There is evidence that the product moment correlation coefficient is greater than 0	A1	2.2b
		(3)	
(d)	Higher $\bar{t}$ suggests overseas and not Perth…lower wind speed so perhaps not close to the sea so suggest **Beijing**	B1	2.4
		(1)	
			(6 marks)

Notes:

(a)

B1: for a correct statement (unreliable) with a suitable reason

(b)

B1: for a correct statement

(c)

B1: for both hypotheses in terms of ρ

M1: for selecting a suitable 5% critical value compatible with their H_1

A1: for a correct conclusion stated

(d)

B1: for suggesting Beijing with some supporting reason based on t or w

Allow Jacksonville with a reason based just on higher $\bar{t}$

Question 10

Question	Scheme	Marks	AOs
5 (a)	The seeds would be destroyed in the process so they would have none to sell	B1	2.4
		(1)	
(b)	[S = no. of seeds out of 24 that germinate, $S \sim B(24, 0.55)$]		
	T = no. of trays with at least 15 germinating. $T \sim B(10, p)$	M1	3.3
	$p = P(S \geqslant 15) = 0.299126...$	A1	1.1b
	So $P(T \geqslant 5) = 0.1487\ldots$ awrt **0.149**	A1	1.1b
		(3)	
(c)	n is large and p close to 0.5	B1	1.2
		(1)	
(d)	$X \sim N(132, 59.4)$	B1	3.4
	$P(X \geqslant 149.5) = P\left(Z \geqslant \frac{149.5-132}{\sqrt{59.4}}\right)$	M1	1.1b
	$= 0.01158\ldots$ awrt **0.0116**	A1cso	1.1b
		(3)	
(e)	e.g The probability is very small therefore there is evidence that the company's claim is incorrect.	B1	2.2b
		(1)	
			(9 marks)

Notes:

(a)
B1: cao

(b)
M1: for selection of an appropriate model for T
1st A1: for a correct value of the parameter p (accept 0.3 or better)
2nd A1: for awrt 0.149

(c)
B1: both correct conditions

(d)
B1: for correct normal distribution
M1: for correct use of continuity correction
A1: cso

(e)
B1: correct statement

Question 11

If they use *g* = 9.81 or 10 in this question, penalise once for whole question.

Question	Scheme	Marks	AOs
2(a)	Attempt to find the displacement after 10 s	M1	3.1b
	$39.2\times10-\frac{1}{2}g\times10^2$ **OR** $-39.2\times10+\frac{1}{2}g\times10^2$	A1	1.1b
	98 (m) (must be positive)	A1	1.1b
		(3)	
2(b)	Complete method to find either half the time or the full time	M1	3.1b
	Correct equation e.g. $0=24.5-gt$ **OR** $-24.5=24.5-gt$	A1	1.1b
	5 (s)	A1	1.1b
		(3)	
2(c)	e.g. (include) air resistance	B1	3.5c
		(1)	
			(7 marks)

Notes:		**Penalise explicit use of *g* = 9.81 or 10 once for the whole question the first time it occurs.**
2a	M1	Complete method, using $s=ut+\frac{1}{2}at^2$ or possibly $s=vt-\frac{1}{2}at^2$ with the motion reversed, or an 'up and down' method i.e an appropriate equation for the motion from *O* to the top **AND** an appropriate equation from the top down to the ground **AND** combining to give the total distance
	A1	Correct expression (s) **N.B.** If using an 'up and down method', this mark is for **all** the intermediate values: Distance up = 78.4, Time up = 4, time down = 6, distance down = 176.4 **AND** combining correctly i.e. (176.4 – 78.4) or (78.4 –176.4) These are the values for *g* = 9.8
	A1	cao
2b	M1	Complete method to find half the time or the full time. Allow inequalities. e.g. for half the time, they may find *t* = 4 and *t* = 1.5 and subtract e.g. for the full time, they may find *t* = 6.5 and *t* = 1.5 and subtract
	A1	Correct equation or equations if they are using more than one.
	A1	cao
2c	B1	e.g. (use) a more accurate value of *g*, (include) spin of the stone, (include)shape of the stone, (include) size of the stone, (include) wind effects , rotation B0 if any incorrect extras are included e.g. the mass or weight of the stone DO NOT ALLOW NEGATIVES OF THESE e.g there is no air resistance

Question 12

Question	Scheme	Marks	AOs
3(a)	$15-3^2-2\times3=0$ *	B1*	1.1b
		(1)	
3(b)	Differentiate *v* wrt *t*	M1	2.1
	$-2t-2$	A1	1.1b
	$8\ (\text{m s}^{-2})$	A1	1.1b
		(3)	
3(c)	Integrate *v* w.r.t. *t*	M1	1.1b
	$15t-\frac{1}{3}t^3-t^2$	A1	1.1b
	Total distance = $\left[15t-\frac{1}{3}t^3-t^2\right]_0^3-\left[15t-\frac{1}{3}t^3-t^2\right]_3^4$ **OR** $s_3+(s_3-s_4)$ where s_3 means the value of their integral when t = 3. **N.B.** Allow the negative of this.	M1	3.1a
	$\frac{94}{3}$ (m)	A1	1.1b
		(4)	
			(8 marks)

Notes:		
3a	B1*	Correct expression, correctly evaluated to give 0 **OR** $0=15-t^2-2t$ t = 3
3b	M1	Differentiate *v*, with at least two powers decreasing by 1
	A1	Correct expression
	A1	cao (must be positive)
		N.B. If they give 8 as their answer, without any working, this can score all 3 marks.
3c	M1	Integrate *v*, with at least two powers increasing by 1 (allow if only two terms integrated) .
	A1	Correct expression. Ignore (+ *C*)
	M1	Complete method to find the total distance or displacement
	A1	Accept 31(m) or better, must be positive
		N.B. If the indefinite integral ($15t-\frac{1}{3}t^3-t^2$) is never seen, they score nothing, even if the correct answer appears, as this indicates they have used a calculator to do the whole question.