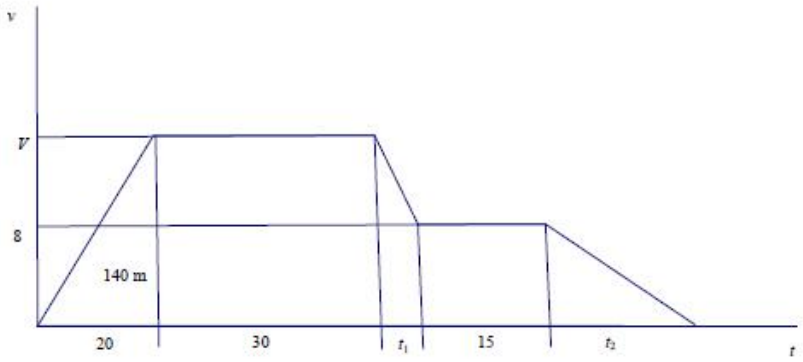
Mark Scheme

Q1.

Question Number	Scheme	Marks
(a)		B1 $0 < t < 50$ B1 $50 < t$ B1 (V,8,15, 20,30) (3)
(b)	Use area under graph or *suvat* to form an equation in V only. $140 = \frac{1}{2} \times 20 \times V$ $V = 14$	M1 A1 (2)
(c)	$8 = V - \frac{1}{2}t_1$ (and /or $0 = 8 - \frac{1}{3}t_2$) $t_1 = 12$, (and/or $t_2 = 24$) Total time = $20 + 30 + t_1 + 15 + t_2 = 101$ (seconds)	M1 A1 **DM**1 A1 (4)
(d)	Total distance $= 140 + 30V + \frac{V+8}{2}t_1 + 15 \times 8 + \frac{1}{2} \times 8 \times t_2$ $= 140 + 30 \times 14 + 11 \times 12 + 15 \times 8 + 24 \times 4$ =908 (m)	M1A2 **ft** A1 (4)
		[13]

Notes for Question

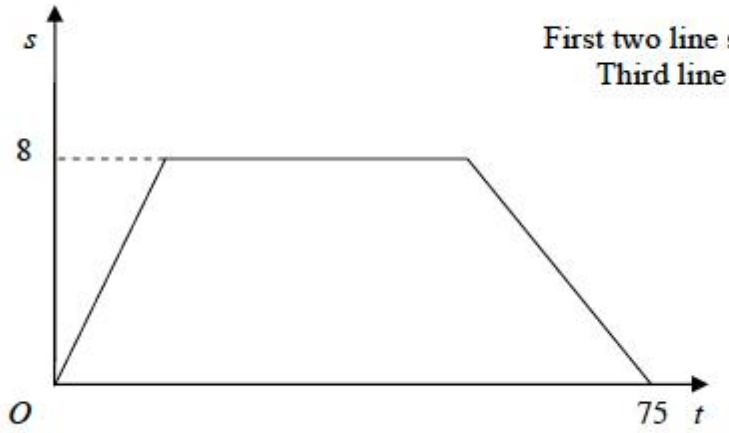
Question (a)
First B1 for shape of graph for $0 \leq t \leq 50$
Second B1 for shape of graph for $t > 50$
Third B1 for V, 8, 15, 20, 30 appropriately used

Question (b)
M1 for use of area under graph (must have '1/2') or *suvat* to obtain an equation in V only.
A1 for $V = 14$

Question (c)
First M1 for use of either $8 = V - \frac{1}{2}t_1$ or $0 = 8 - \frac{1}{3}t_2$
First A1 for either $t_1 = 12$ or $t_2 = 24$
Second M1, **dependent on the first M1**, for $20 + 30 + t_1 + 15 + t_2$ (must include all 5 times)
Second A1 for 101 (s)

Question (d)
First M1 for an expression for the total area (distance) **including all parts of the motion**. Where a triangle or trapezium is used , a '1/2' must be seen.
Second A2 **ft** on their V, t_1 and t_2, -1 each error.
Fourth A1 for 908 (m).

Q2.

(a)	 First two line segments Third line segment 8, 75	B1 B1 B1 (3)
(b)	$\frac{1}{2}\times 8\times(T+75)=500$ Solving to $T=50$	M1 A2 (1,0) DM1 A1 (5) **[8]**

Q3.

Question Number	Scheme	Marks
	(a) $v^2 = u^2 + 2as \Rightarrow 28^2 = u^2 + 2\times 9.8\times 17.5$	M1 A1
	Leading to $u = 21$ ✱ cso	A1 (3)
	(b) $s = ut + \frac{1}{2}at^2 \Rightarrow 19 = 21t - 4.9t^2$	M1 A1
	$4.9t^2 - 21t + 19 = 0$	
	$t = \frac{21 \pm \sqrt{21^2 - 4\text{x}4.9\text{.x}19}}{9.8}$	
	$t = 2.99$ or 3.0	DM1 A1 A1
	$t = 1.30$ or 1.3	(5)
	(c) N2L $4g - 5000 = 4a$	M1 A1
	$(a = -1240.2)$	
	$v^2 = u^2 + 2as \Rightarrow 0^2 = 28^2 - 2\times 1240.2\times s$	
	Leading to $s = 0.316$ (m) or 0.32	M1 A1 (4)
		[12]
	OR	
	$\frac{1}{2}$ x 4 x $28^2 + 4gs = 5000s$	M1 A1
	Work-Energy: $s = 0.316$ or 0.32	M1 A1

(a)

First M1 for a complete method for finding u e.g.
$28^2 = u^2 + 2g\times 17.5$
or $282 = u^2 + 2(-g)\times(-17.5)$
or $282 = 2gs \Rightarrow s = 40$ then $0^2 = u^2 + 2(-g)\times(22.5)$
condone sign errors
First A1 for a correct equation(s) with $g = 9.8$
Second A1 for "$u = 21$" PRINTED ANSWER
N.B. Allow a verification method, but they must state, as a conclusion, that "$u = 21$" , to score the final A1.

(b)

First M1 for a complete method for finding at least one t value i.e. for producing an equation in t only.
(condone sign errors but not missing terms)
First A1 for a correct quadratic equation in t only or TWO correct linear equations in t only.
Second DM1, dependent on first M1, for attempt to solve the quadratic or one of the linear equations.
Second A1 for 3.0 or 3 or 2.99
Third A1 for 1.3 or 1.30

(c)

First M1 for resolving vertically with usual rules.
First A1 for a correct equation
Second M1 for use of $v^2 = u^2 + 2as$, with $v = 0$, $u = 28$ or $u = 0$ and $v = 28$ and their a, (or any other complete method which produces an equation in s,which could be negative)
M0 if they haven't *calculated* a value of a.
Second A1 for 0.32 or 0.316. (must be positive since it's a distance)

Q4.

Question	Scheme	Marks	AOs
(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)	
(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)	
(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.**
a	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
b	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
c	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

Q5.

Question	Scheme	Marks	AOs
(a)	$14.7=-14.7+9.8T$ or $0=14.7T-\frac{1}{2}\times9.8T^2$ or $0=14.7-9.8\times\left(\frac{1}{2}T\right)$ oe	M1	3.4
	$T=3$	A1	1.1b
		(2)	
(b)	$s_1=\frac{(14.7+0)}{2}\times1.5$ $(11.025$ or $\frac{441}{40})$	M1	1.1b
	$s_2=\frac{1}{2}\times9.8\times2.5^2$ $(30.625$ or $\frac{245}{8})$ **OR** $s_3=14.7\times1+\frac{1}{2}\times9.8\times1^2$ $(19.6$ or $\frac{98}{5})$ **OR** $-s_3=14.7\times4-\frac{1}{2}\times9.8\times4^2$ (- 19.6) (allow omission of – on LHS)	M1	1.1b
	Total distance = s_1+s_2 **OR** $2s_1+s_3$	M1	2.1
	= 41.7 m or 42 m	A1	1.1b
		(4)	
(c)	e.g. Take account of the dimensions of the stone (e.g. allow for spin), do not model the stone as a particle, use a more accurate value for g	B1	3.5c
		(1)	
			(7 marks)

Notes:		**If they use g = 9.81 or 10, penalise once for whole question.**
a	M1	Complete method to find T, condone sign errors (M0 if they only find time to top)
	A1	$T=3$ correctly obtained.
b	M1	Complete method to find one key distance
	M1	Correct method to find another key distance
	M1	Complete method to find the total distance
	A1	41.7 or 42 (after use of $g=9.8$)
c	B1	B0 if there are incorrect extra refinements but ignore extra incorrect statements.