Question Number	Scheme	Marks
3.	Allow a numerical value of g used anywhere apart from the final A marks in (a) and (b) but penalise use of $g = 9.81$ once for whole question	
(a)	$0^2 = U^2 - 2gH$	M1
	$H = \dfrac{U^2}{2g}$	A1
		(2)
(b)	$s_P = \dfrac{1}{2}gt^2$ **OR** $s_P = Ut - \dfrac{1}{2}gt^2$	M1A1
	$s_Q = \dfrac{1}{2}Ut - \dfrac{1}{2}gt^2$ $\quad$ $s_Q = \dfrac{1}{2}U(t - \dfrac{U}{g}) - \dfrac{1}{2}g(t - \dfrac{U}{g})^2$	M1A1
	$s_P + s_Q = H$ $\quad$ $s_P = s_Q$ $\Rightarrow \dfrac{1}{2}Ut = \dfrac{U^2}{2g}$ $\quad$ $\Rightarrow Ut - \dfrac{1}{2}gt^2 = \dfrac{1}{2}U(t - \dfrac{U}{g}) - \dfrac{1}{2}g(t - \dfrac{U}{g})^2$	M1
	$t = \dfrac{U}{g}$ $\quad$ Answer $= (t - \dfrac{U}{g}) = \dfrac{U}{g}$	A1
		(6)
(c)	$s_P = \dfrac{1}{2}g\left(\dfrac{U}{g}\right)^2$ **OR** $s_P = U(\dfrac{2U}{g}) - \dfrac{1}{2}g(\dfrac{2U}{g})^2$ or $s_Q = \dfrac{1}{2}U\left(\dfrac{U}{g}\right) - \dfrac{1}{2}g\left(\dfrac{U}{g}\right)^2$ $\quad$ or $s_Q = \dfrac{1}{2}U\left(\dfrac{U}{g}\right) - \dfrac{1}{2}g\left(\dfrac{U}{g}\right)^2$	M1 A1
	Collide at the point O or at the point of projection. (At the same level as O is A0)	A1
		(3)
		(11)
	Notes for question 3	
3(a)	M1 Complete method to find an equation in H, U and g *only* .Condone sign errors	
	A1 Correct expression for H in terms of U and g. (A0 if they use h or s in their answer but allow for the M mark)	
3(b)	**N.B.** When awarding marks, must use EITHER the LH column OR the RH column, **not** a mixture of both. Award as many marks as possible. M1 Complete method to find s_P in terms of t, where $t = 0$ is when Q is projected upwards. The alternative arises when $t = 0$ is taken to be when P is projected *upwards*. Condone sign errors.	
	A1 Correct equation (using their H where it is used) Allow: $s_P = \dfrac{1}{2}gt^2$ or $s_P = -\dfrac{1}{2}gt^2$ or $s_P = H - \dfrac{1}{2}gt^2$ or $s_P = -(H - \dfrac{1}{2}gt^2)$	

Question Number	Scheme	Marks
	or $s_P = U(t + \frac{U}{g}) - \frac{1}{2}g(t + \frac{U}{g})^2$	
	M1 Complete method to find s_Q in terms of t. Condone sign errors.	
	A1 Correct equation (using their H where it is used) Allow: $s_Q = \frac{1}{2}Ut - \frac{1}{2}gt^2$ or $s_Q = -(\frac{1}{2}Ut - \frac{1}{2}gt^2)$ Or $s_Q = H - (\frac{1}{2}Ut - \frac{1}{2}gt^2)$ or $s_Q = -(H - (\frac{1}{2}Ut - \frac{1}{2}gt^2))$	
	M1 Use of $s_P + s_Q = H$ oe **OR** $s_P = s_Q$ oe to obtain a CORRECT equation in t, U and g *only*	
	A1 Correct expression for t in terms of U and g.	
3(c)	M1 Sub their t value, provided it's POSITIVE, into their equation for s_P or s_Q	
	A1 Correct unsimplified expression	
	A1 Correct conclusion	