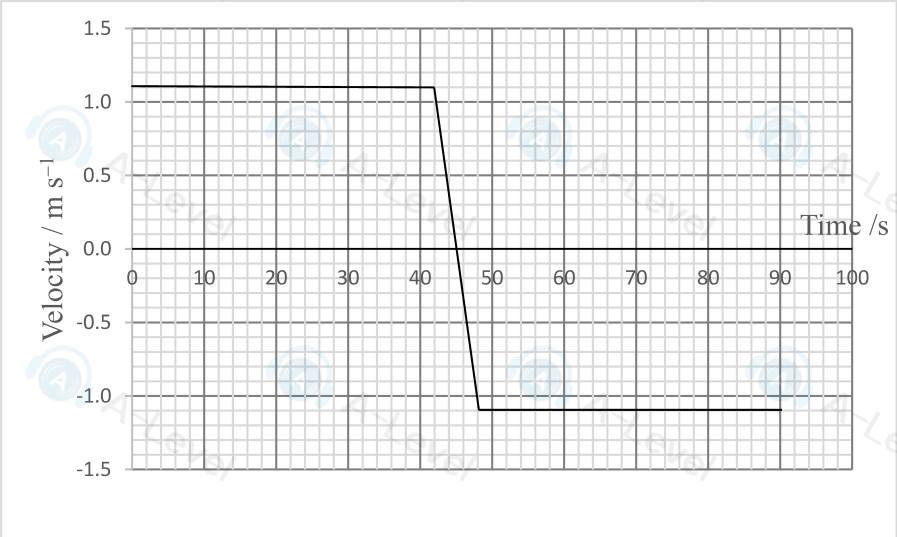
5	**C 0.850 m** Incorrect Answers: a metre rule measures to 3 sf so the final answer must be to 3 sf regardless of the units used A – answer to 2 sf in cm B – answer to 2 sf in m D – answer to 2 sf in m (using standard form)	1

8	**The only correct answer is D** (-9.8 m s^{-1}) A is not correct because the ball is in freefall so has acceleration due to gravity B is not correct because the ball is in freefall so has acceleration due to gravity C is not correct because the ball is in freefall so has acceleration due to gravity	1

3	**The only correct answer is D (The forces have the same magnitude.)** A is not correct because the forces act on two different objects B is not correct because the forces act in opposite directions C is not correct because the forces can act between stationary objects	1

9	**The only correct answer is C ($90 - 49 - (5 \times 4)$)** A is not correct because this gives the resultant force B is not correct because the resultant force is not zero D is not correct because this assumes that the object is accelerating downwards	1

Question Number	Answer		Mark
13(a)	• Use of $v = s/t$ **Or** use of gradient	(1)	
	• $v = (\pm)$ 1.1 to 1.2 (m s^{-1})	(1)	
	• Scaling of the velocity axis so that the graph covers at least 50% of the paper above and below the axes. (A minimum of 1 number on each axis required e.g. 1 and –1)	(1)	
	• A positive constant velocity from 0 to 42 s and the same negative constant velocity from 48 s to 90 s with connecting line/curve (tolerance of ± 1 s)	(1)	4
	<u>Example of calculation</u> Initial velocity $= \frac{46\text{ m}}{40\text{ s}} = 1.15\text{ m s}^{-1}$		
			
13(b)(i)	The graph should be a curve initially	(1)	
	with a decreasing gradient up to 15 m (by eye) (ignore any part of the graph above 15 m)	(1)	2

<table>
<tr>
<td>13(b)(ii)</td>
<td>1 mark for a simplification (1)

1 mark for a corresponding explanation (1)

<table>
<tr><th>Simplification</th><th>Explanation</th></tr>
<tr><td>Velocity constant
Or velocity doesn’t change
Or velocity is an average
Or no regions of acceleration/deceleration</td><td>• Variation in velocity during each stroke
• The force applied to the swimmer/water varies (within the stroke)
• As the swimmer moves above/below water to breathe, the velocity changes
• The speed would change as they went from gliding to swimming</td></tr>
<tr><td>The velocity of the swimmer has the same magnitude in both parts of the race</td><td>The swimmer may have tired and this could be less for the second half of the race</td></tr>
<tr><td>The initial velocity after the turn would be greater</td><td>The swimmer would probably glide (underwater) after the turn</td></tr>
<tr><td>Gradient should initially increase from zero</td><td>Swimmer initially pushes off from starting block/turn</td></tr>
</table>

Treat references to drag as neutral.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total for question 13</td>
<td>8</td>
</tr>
</table>

Question Number	Answer		Mark
16(a)(i)	• Use measurement and scaling factor (1)	**(1)**	
	• $h = 3.4 \pm 0.1$ cm	**(1)**	
	OR		
	• Use of $s = \frac{1}{2}at^2$ with $t = 0.083$ s	**(1)**	
	• $h = 3.4$ cm	**(1)**	**(2)**

16(a)(ii)	• Use of (average) speed = s/t with s = value from part (a)(i)	**(1)**
	• Use of initial speed = 2 × average speed	**(1)**
	• Speed = 0.82 m s^{-1} ecf from (a)(i)	**(1)**
	OR	
	• Use of $E_g = mgh$ with h = value from (a)(i)	**(1)**
	• Use of $½mv^2 = E_g$(initial)	**(1)**
	• Speed = 0.82 m s^{-1} ecf from (a)(i)	**(1)**
	OR	
	• Use of $v = u + at$ with v = 0	**(1)**
	• Use of $a = -g$	**(1)**
	• Speed = 9.81 × 0.083 = 0.81 m s^{-1}	**(1)**
	OR	
	• Use of with $s = ut + ½at^2$ with s = value from part (a)(i)	**(1)**
	• Use of $a = -g$	**(1)**
	• Speed = 0.82 m s^{-1} ecf from (a)(i)	**(1)**
	Example of calculation $u = s/t - ½at$ $u = 0.034/0.083 + ½ \times 9.81 \times 0.083$	
	OR	
	• Use of $v^2 = u^2 + 2as$ with s = value from (a)(i) and $v = 0$	**(1)**
	• Use of $a = -g$	**(1)**

	• Speed = 0.82 m s^{-1} ecf from (a)(i) **(1)** Example of calculation Actual distance travelled by popcorn = 6.2 cm ÷ 1.8 = 3.4 cm (average speed) = $\frac{0.034\text{ m}}{83\times10^{-3}\text{ s}} = 0.41\text{ m s}^{-1}$ Initial speed = 2 × average speed = 0.82 m s^{-1}	**(3)**
16(b)	• Use of 14% to determine mass (of water/popcorn). **(1)** **Or** $m_{popcorn}/m_{water}$ = 86/14 • Use of $p = mv$ **(1)** • Use of momentum conservation **(1)** • v = (–) 9.2 m s^{-1} **(1)** Example of calculation 0 = (0.0946 g × 1.5 m s^{-1}) + (0.0154 g × v) $v = \frac{-0.0946\text{ g}\times1.5\text{ m s}^{-1}}{0.0154\text{ g}}$ v = –9.21 m s^{-1}	**(4)**
	Total for question 16	**9**