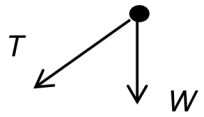
Question Number	Answer		Mark
17ai	Arrow down marked weight/W/mg Arrow labelled *T* drawn at 40° downwards from horizontal by eye  	(1) (1)	**2**
17aii	There is a resultant force due to tension and weight Resultant force is at 90° to the motion of the hammer (Accept resultant force directed towards the centre of the circular path)	(1) (1)	**2**
17aiii	Use of velocity = $f \times 2\pi r$ **Or** $\omega = f \times 2\pi$ Use of $a = v^2 / r$ **Or** $a = r\,\omega^2$ $a = 460\ \text{m s}^{-2}$ Example of calculation $v = 2.8\ \text{s}^{-1} \times 2\pi \times 1.5\ \text{m} = 26.4\ \text{m s}^{-1}$ $a = 26.4^2\ (\text{m s}^{-1})^2 / 1.5\ \text{m} = 464\ \text{m s}^{-2}$	(1) (1) (1)	**3**

17b	**Either** • Use of trigonometry for a component of velocity (1) • Use of $v^2 = u^2 + 2as$ (with $a = g$) (1) • Use of $v = u + at$ (with $a = g$) (1) • Use of $v = s/t$ in the horizontal plane (1) • range = 81 m so doesn't beat record (1) **Or** • Use of trigonometry for a component of velocity (1) • Use of $s = ut + \frac{1}{2}at^2$ (with $a = g$) (1) • the ut term has the opposite sign to s and at^2 term (1) • Use of $v = s/t$ in the horizontal plane (1) • range = 81 m so doesn't beat record (1) <u>Example of calculation</u> Initial vertical component velocity = 28.0 sin 40° = 18.00 m s^{-1} Horizontal component velocity = 28.0 cos 40° = 21.45 m s^{-1} $s = \frac{v^2 - u^2}{2a} = \frac{0 - (18\ \text{m s}^{-1})^2}{2 \times 9.81\ \text{m s}^{-2}} = 16.5\ \text{m}$ Time to highest point, $t = \frac{v-u}{a} = \frac{(-18-0)\ \text{m s}^{-1}}{-9.81\ \text{m s}^{-2}} = 1.83\ \text{s}$ Distance to ground = 16.5 m + 1.5 m = 18.0 m Time from highest point to ground, $t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2\times(-18.0\ \text{m})}{-9.81\ \text{m s}^{-2}}} = 1.92\ \text{s}$ Total time of flight = 1.83 s + 1.92 s = 3.75 s Range = 21.45 m s^{-1} × 3.75 s = 80.4 m This is less than 83 m, so it would not break the record.	**5**
	Total for question 17	**12**