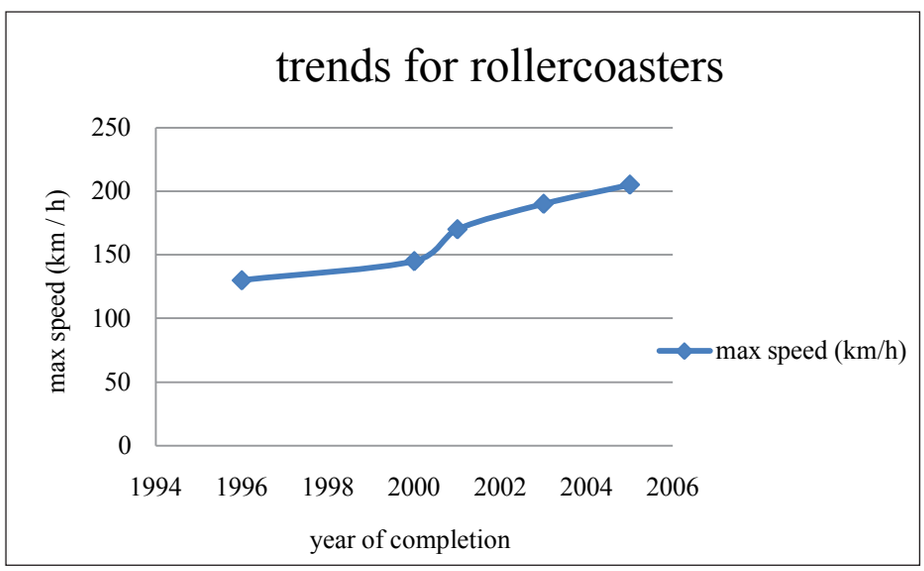
Motion and Forces in a Gravitational Field: World records and fun fairs – Comprehension

set	number	solution
Comp1	1	Short arms – you raise the weight through a shorter distance so do less work against gravity
	2a	Power = work done / time Estimate length of arms = 1 m. Work done =force × distance moved = 138 × 10^3 kg × 9.81 N kg^{-1} × 1 m = 1.35 × 10^6 J Power = work done / time = 1.35 × 10^6 J / 3600 s = 375 W
	2b	375 W / 0.746 kW =0.50 Bench presser has a horsepower of 0.5.
	3	A reasonable estimate following the trend would be larger than 250 km /h. This is probably an unreliable prediction. Some reasons would be : do people actually want to travel that fast, the improvements have been only small indicating that technology isn't changing just being slightly improved so unlikely to keep on increasing, safety concerns. 
	3a	Equating g.p.e. and k.e. leads to $v = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 127} = 49.9\ m\ s^{-1}$
	3b	Answer to 3a is less than 200 km h^{-1} (equivalent to 55.5 m s^{-1}). This is probably because the rollercoaster doesn't just 'drop' it will also have a motor to accelerate it downwards in addition to the acceleration provided by gravity.
	5a	Resolving horizontally t=128/u cos45° Substitute into s= ut + ½at^2 (vertically) $-1 = \frac{u \sin 45^o \times 128}{u \cos 45^o} + \frac{1}{2} \times -9.8 \times \frac{128^2}{u^2 \cos^2 45^o}$ $-129\,u^2 \cos^2 45^o = -80300$ u = 35.3 m s^{-1}
	5b	See diagram on page 21 of Exploring Physics
	5c	Vertically when s = s_{max} v=0 $s = \frac{u^2}{2a} = \frac{(35.3 \times \sin 45^o)^2}{2 \times 9.8}$ s = 31.8 m s^{-1}
	5d	Use the same method as 5a, -54.65 u^2 = -80300 u = 38 .3 m s^{-1}
	6a	400 km h^{-1} = 111 m s^{-1} $a = \frac{v^2}{r} = \frac{111^2}{450} = 27.4\ m\ s^{-2}$ 27.4 $m\ s^{-2}$/ 9.8 $m\ s^{-2}$=2.8
	6b	$t = \frac{2\pi r}{v}$ for whole circle, for 180° divide by 2 $t = \frac{2\pi \times 450\ m}{111\ m\ s^{-2}} = 12.7\ s$
	7a	Using the same method as 6a, 800 km h^{-1} = 222 m s^{-1}