

## Questions

A 70 kg mountain bike rider, wearing a 550 gram helmet, was riding down a steep descent at 45 km/h when the front wheel of his bike collided with a branch lying across the dirt track. The rider was propelled over the handle bars and impacted his head against a tree trunk. The crash report presented by the crash investigators stated the rider impacted in the forehead region of his helmet and it was estimated the helmeted head of the rider came to rest in 6 milliseconds after the initial impact. The acceleration due to gravity is given as:  $g = 9.8 \text{ m/s}^2$ .

(a) Calculate the rider's:

- (i) Momentum
- (ii) Deceleration in G's

(b) Comment on the rider's chance of surviving serious head injuries or possibly death, given the threshold for concussion is  $\sim 100 \text{ G's}$  and severe brain injuries, possibly, death is  $\sim 275 \text{ g's}$ . If the rider was not wearing a helmet then comment on his chance of survival by referring to the Wayne State Tolerance Curve below for head without head protection.

## Answer

- (i) Momentum: convert km/h to m/s (metres per second)  $\rightarrow 45 \text{ km/h} = 12.5 \text{ m/s}$ . Use momentum = mass x velocity  $\rightarrow p = m \times v \rightarrow$  momentum with helmet  $\rightarrow p = 70.55 \times 12.5 = 875 \text{ kg.m/s}$ .
- (ii) Deceleration: Use deceleration = velocity/time  $\rightarrow a = v/t \rightarrow a = 12.5/0.006 = 2083 \text{ m/s}^2$ ; convert to g's =  $2083/9.8 = 213 \text{ g's}$

(b) The fact the rider was wearing a helmet saved the rider's life:  $213 \text{ g's} < 275 \text{ g's}$ . If the rider had not been wearing a helmet he would have either sustained a serious brain injury or possible death since  $213 \text{ g's}$  is above the tolerance curve.

