Plenary Questions on Circular Motion

1. A motorway interchange includes a smooth bend of radius 23 m. At what angle must it be banked so that a car can take the bend in an unpowered state at 20 ms^{-1}?

   Formula: $v^2 = gr \tan \theta$

   $\tan \theta = v^2/gr = 20^2 \div (9.8 \times 23) = 1.76$

   $\theta = \tan^{-1} 1.76 = 60$ degrees (a bit steep)

2. A pilot in a stunt plane loops the loop in a vertical circle of radius 0.6 km at a constant speed of 250 km/hour. If the pilot has a mass of 75 kg calculate:

   (a) the maximum resultant force on the pilot;
   (b) the minimum resultant force on the pilot stating where in the loop each occurs.

   (a) Pilot's weight = 75 × 9.8 = 735 N

   Speed = 250 000 ÷ 3600 = 69.4 m/s

   Centripetal force = $(75 \times 69.4^2) \div 600 = 603$ N

   At the top:
   R = 603 – 735 = -132 N (i.e. he is in negative g)

   At the bottom:
   R = 603 + 735 = 1338 N

   (b) Maximum force occurs at the bottom of the loop; minimum at the top.