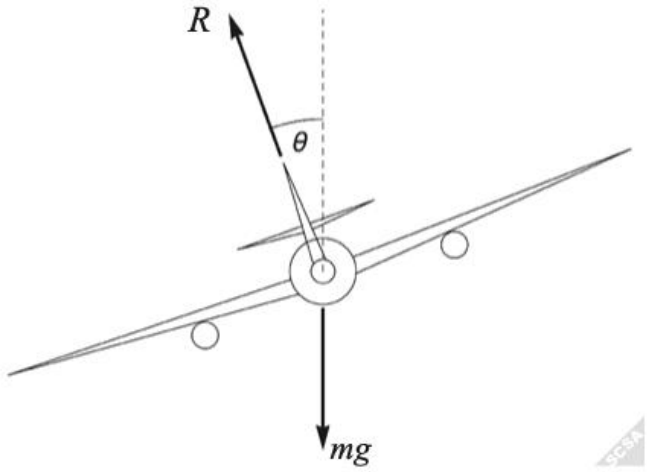
Question 17 **(13 marks)**

Aeroplanes are designed to produce an upthrust that counters their weight force. This allows them to maintain altitude. The magnitude of this upthrust (R) is directly proportional to the forward speed of the aircraft. It always acts perpendicular to the wings. When changing direction, the aeroplane banks in a circular path. A free body diagram of a banking aeroplane is shown below.



(a) Draw a vector diagram showing how the weight force and the upthrust produce a resultant centripetal force. Label the resultant force and include the angle θ shown in the free body diagram. (3 marks)

(b) Calculate the centripetal force on a 5.60×10^3 kg aeroplane banking at an angle of 15.0° to the vertical while maintaining constant altitude. (3 marks)

Answer _____ N

(c) If the aeroplane is travelling at 4.50×10^2 km h^{-1}, calculate the radius of the circular path it takes when banking while maintaining constant altitude. (3 marks)

Answer _____ m

(d) With reference to your vector diagram in part (a) and the text, explain why aeroplanes need to increase their speed to maintain altitude when banking. (4 marks)