Edexcel A level Maths A model for friction

Section 1: Friction

Exercise level 3 (Extension)

1. A particle lies on a rough plane inclined at an angle θ to the horizontal. The coefficient of friction between particle and plane is μ. When it is pushed by a force P directed upwards along a line of greatest slope, it is on the point of slipping upwards. When it is drawn downwards by a force kP along a line of greatest slope, it is on the point of slipping downwards. Express the coefficient of friction μ in terms of k and θ.

2. A particle is projected with speed u upwards along a line of greatest slope of a rough plane inclined at an angle θ to the horizontal. The coefficient of friction between the particle and the plane is μ. It travels up the plane until it comes momentarily to rest.
   (i) Find the time taken and distance travelled in terms of u, μ, θ, and g.
   (ii) What relation must be satisfied by μ and θ if it is to start to move back down the plane?
   (iii) Assuming that condition is satisfied, find the further time taken to travel back to its starting point, and the speed it has on reaching there.

3. A straight groove is constructed alternately of sections of lengths $2b$ and b, which are rough and smooth respectively. Two identical particles slide in the groove. The coefficient of friction between the rough parts and each particle is μ. The groove is supported as an incline which makes an angle θ to the horizontal, and the two particles, now joined by a light rod of length b, are placed so that the first is at the top and the second at the bottom of a smooth section, and released.
   (i) Find the condition to be satisfied by μ if the two particles start to move.
   (ii) If that condition is satisfied, find the speed which the lower particle has reached as it arrives at the bottom of the second smooth section of groove.