Edexcel AS Mathematics Force and Newton's laws of motion

Section 1: Force diagrams and equilibrium

Exercise level 3 (Extension)

1. The picture shows a double-decker bus undergoing a tilt test. The test verifies that the vehicle is stable enough for the public roads. Draw a diagram of the bus to show the forces acting on it while tilted as shown.

2. A particle lies on a rough horizontal plane. It is pulled by a horizontal force P of magnitude Lkt N, where t seconds is time and L, k are constants, and by another force Q of magnitude Lt^2 N in the opposite direction. The maximum available friction (in any direction) is L N. (Friction takes its maximum value when the particle begins to slip).
   (i) If $k < 2$, does it move in the direction of P or of Q when it begins to slip?
   (ii) What happens if $k > 2$?
   (iii) What happens if $k = 2$?

3. A passenger train unit has five cars. The two end cars and middle one are powered and the other two are trailers. Each powered car has a mass of 120 tonnes and each trailer 80 tonnes. The resistance to the motion of each car other than the leading one is 1 kN. The tractive effort of each powered car is 10 kN. The train is travelling at constant speed of 250 km h^{-1} on level straight track.
   (i) What is the resistance to the leading car?
   (ii) Find the tension or compression in each coupling.
   If the front power car is shut off owing to a fault, the train can only maintain a lower steady speed.
   (iii) Assuming that the resistances fall proportionately to speed but the tractive efforts are unchanged what is that steady speed?
   The leading power car is still in failure.
   (iv) The rear power car's tractive effort is reduced so that the coupling by which it is attached to the car in front is to be in tension rather than compression (when travelling at a steady speed). What is the maximum value of the tractive effort for this to be achieved?