PHY151 PRACTICE PROBLEMs FOR WEEK 5 PRACTICALS

Q1: Consider the situation that a box of $10kg$ mass needs to be dragged across a distance of $1000m$ to reach its receiver, who demands to receive the box within $100s$. Now, assume the ideal case that the surface between the ground and the box is frictionless. What is the minimum constant force needed to be applied to the box, so the time condition would be satisfied? The box start at rest.

Q2: Now get closer to the real world by considering the coefficient of kinetic friction on the surface between the box and the ground is $\mu = 0.5$ instead of 0. What is the minimum constant force needed to satisfy the time condition in this situation? Here assume the gravitational acceleration $g = 10$ from here till the end of this practise problem set for the sake of simplicity.

Q3: Now the receiver demands an additional small box of cargo, which has mass $1kg$, to be placed on top of the large box and delivered together. Knowing the coefficient of static friction between the large box and the small box is 0.5, What is the maximum constant acceleration the combination of boxes could achieve before the small box begin to slip? How long it takes to deliver the boxes under this acceleration? Is the time requirement satisfied?

Q4: A physicist, who favours the ideal world over the real world, has come to modify the situation to be more ideal by making the surface between the two boxes frictionless. What is the maximum constant acceleration possible for the two boxes now, before the small box begin to slip?

Q5: To complete the delivery, now the small box is attached at the back of the large box by a spring with negligible mass and spring constant $k = 100N/m$. The coefficient of kinetic friction between the small box and the ground is $\mu_b = 0.5$. Again, the delivery needs to be completed within $100s$. What is the force needed to drag the large box? How long will the spring between the boxes stretch during the movement?

Q6: The physicist is back with another upgrade: a handle has been installed on the large box with an angle of $45°$ above the ground. Now the applied pulling force would be along the handle's direction instead of horizontal. What is the force needed now to deliver the boxes on time? Is the force needed smaller now?