Friction Overview (3/6/21)

Q1 [4 marks]

A sledge with a child onboard is being pulled along on level ground, at a constant speed, by means of a rope inclined at 30° to the horizontal. The sledge and child together have a mass of $100kg$. The coefficient of friction between the sledge and the ground is $\frac{1}{10}$. Assuming that $g = 10$, find the tension in the rope.

Q2 [Problem/M]

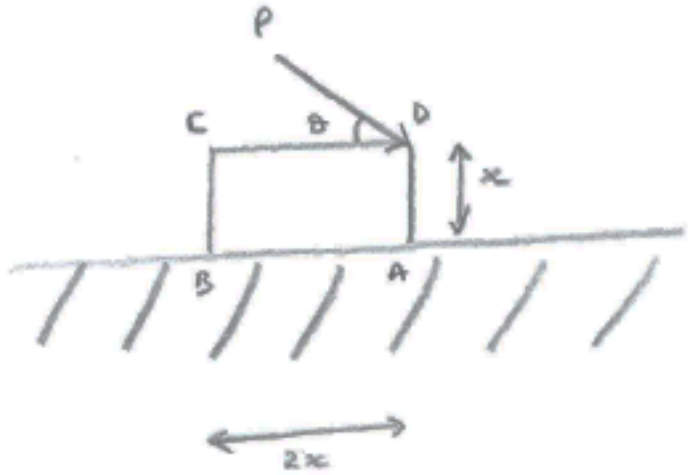
A block rests on a slope which is angled at $\theta°$ to the horizontal. The coefficient of friction between the surface of the slope and the block is $tan\ \alpha$. P_1 is the horizontal force that needs to be applied to the block to stop it from slipping down the slope, whilst P_2 is the greatest horizontal force that can be applied without the block slipping up the slope.

(i) Show that $\frac{P_2}{P_1} = \frac{\tan(\theta+\alpha)}{\tan(\theta-\alpha)}$

(ii) Explain what happens when $\theta < \alpha$

Q3 [9 marks]

A uniform block of mass m rests on a table, and a force P is applied at D, as shown in the diagram. The block has length $2x$ and height x. The coefficient of friction between the block and the table is μ.



(i) If the block is on the point of sliding, find an expression for P.

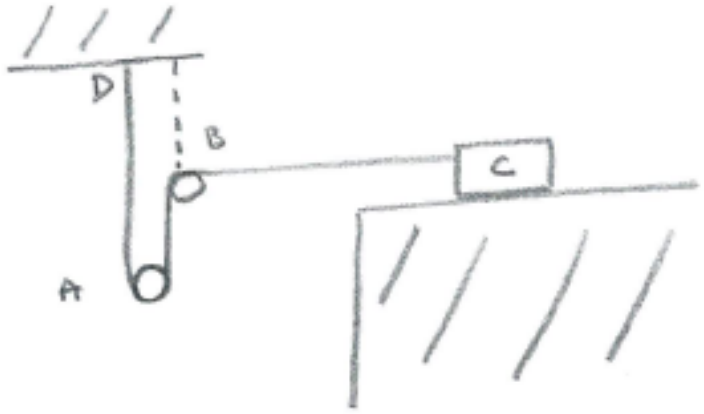
[3 marks]

(ii) If instead the block is on the point of toppling, find an expression for P. [3 marks]

(iii) If the block is to topple before it slides, find a condition on μ.

[3 marks]

Q4 [Problem/H]



Referring to the diagram, A is a smooth pulley of mass 2 kg, which can move up and down; B is a smooth, fixed pulley, and C is a block of mass 1kg, which is initially held at rest on a table. A light inextensible rope is fixed at D, and leads to C, via the two pulleys.

C is now released and accelerates at 2 ms^{-1}. Find the coefficient of friction, μ between C and the table.