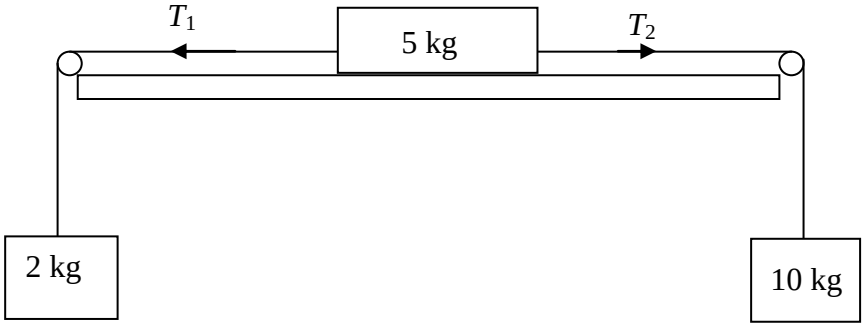
Edexcel A level Maths A model for friction

Topic assessment

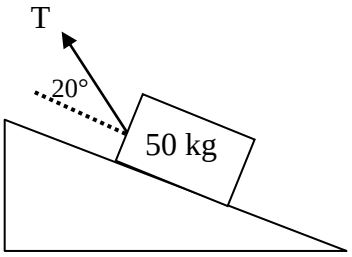
Take g = 9.8 ms^{-2} throughout this test.

1. In the system below, the coefficient of friction between the block and the table is 0.2.



Find the acceleration of the system and the tensions T_1 and T_2. [8]

2. The diagram shows a mass of 50 kg on a slope which makes an angle of 30° with the horizontal. The coefficient of friction between the mass and the slope is 0.25. You may assume that the mass does not tip up.



Find the magnitude of the force T if

(i) the mass is about to move down the slope [5]

(ii) the mass is about to move up the slope [5]

(iii) the mass is accelerating at 5 ms^{-2} up the slope. [5]

3. A large box of mass 50 kg is being pulled across a rough horizontal floor. The coefficient of friction between the box and the floor is 0.6.
Find the force needed to pull the box at a steady speed

(i) if the pulling force is parallel to the floor [3]

(ii) if the pulling force is at an angle of 30° above the horizontal (you may assume that the box does not tip). [4]

The box is now pulled up a slope inclined at 20° to the horizontal.

(iii) Find the least possible value for the coefficient of friction if the box remains at rest when the pulling force is removed. [5]

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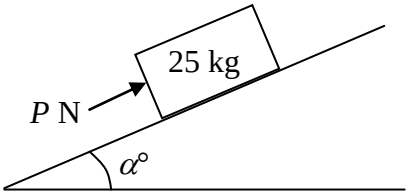
4. A small block of mass 25 kg is on a rough slope inclined at $\alpha°$ to the horizontal. The block is held in equilibrium by a force of magnitude P N applied parallel to the slope and up the slope, as shown in the diagram below.



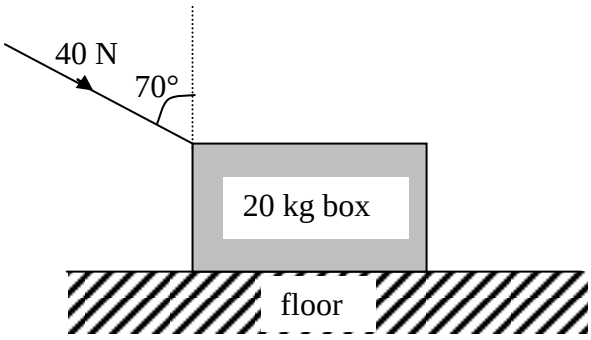
When $P = 259$, the block is about to slip up the slope. When $P = 35$, the block is about to slip down the slope. In each case, the magnitude of the frictional force acting on the block is F N.

(i) Draw separate force diagrams for these two cases, showing all the forces and making clear the direction in which the frictional force acts. [2]

(ii) Calculate the value of α and show that $F = 112$. [5]

(iii) Calculate the coefficient of friction between the block and the slope. [3]

5. A box of mass 20 kg is being pushed along a uniform rough horizontal floor by means of a downward force of 40 N at 70° to the vertical, as shown in the diagram. The box is initially at rest and is travelling at 0.8 ms^{-1} after it has slid 6 m. You may assume that the box does not tip up.



(i) Find the value of the frictional force, assuming that it is constant. Give your answer correct to two significant figures. [6]

(ii) Calculate the value of the coefficient of friction. [3]

When the box is travelling at 0.8 ms^{-1}, the applied force is removed.

(iii) How far does the box slide before coming to rest? [4]

(iv) If the force applied to the box had been 40 N upwards at 70° to the vertical and the box did not tip up, would it have been travelling at the same speed, or faster or slower, after sliding 6 m? You should give a reason for your answer but are not required to calculate the speed. [2]

Total: 60 marks