FRICTION

A2 Unit 4: Applied Mathematics B

Section B: Mechanics

WJEC past paper questions: 2010 – 2017

Total marks available 115 (approximately 2 hours 20 minutes)

1. An object, of mass 5 kg, lies on a rough horizontal surface. The coefficient of friction between the object and the surface is 0·6. A horizontal force of magnitude T N is applied to the object.

   (a) Given that $T = 40$, calculate the magnitude of the frictional force and the acceleration of the object. [5]

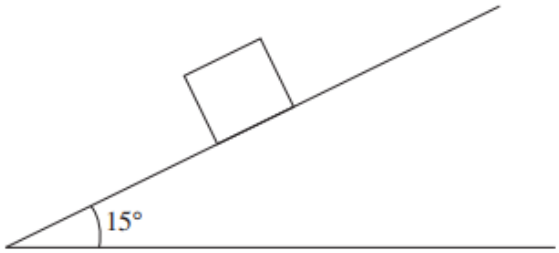
   (b) Given that $T = 20$, describes what happens, giving a reason for your answer. [2]

(January 10)

2. A boy sits on his toboggan and rides it down a straight line path on a snow-covered hill. The path may be modelled as a line of greatest slope of a plane inclined at an angle α to the horizontal, where $\sin \alpha = \frac{5}{13}$. The coefficient of friction between the toboggan and the slope is 0·2. The combined mass of the boy and the toboggan is 52 kg. Find the magnitude of their acceleration. [6]

(Summer 10)

3. The diagram shows an object, of mass 8 kg, on a rough plane inclined at an angle of 15° to the horizontal.

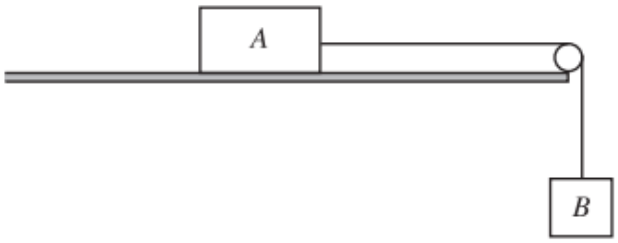


   (a) Given that the object is at rest, calculate the least possible value of the coefficient of friction. Give your answer correct to two decimal places. [6]

   (b) Given that the coefficient of friction is 0·1, find the acceleration of the object down the plane. [4]

(Summer 11)

4. The diagram shows two bodies A and B, of mass 5 kg and 3 kg respectively, connected by a light inextensible string passing over a smooth light pulley fixed at the edge of a **rough** horizontal table. The heavier body A lies on the table and the lighter body B hangs freely below the pulley.



Initially, the system is at rest with the string just taut. The system is then released.

(a) Given that the coefficient of friction between A and the table is 0·4, calculate the magnitude of the acceleration of A and the tension in the string. [9]

(b) Given instead that the bodies remain at rest, find the least value of the coefficient of friction. [3]

(January 11)

5. A rough plane is inclined at an angle α to the horizontal where $\sin\alpha = \frac{3}{5}$. A body of mass 80 kg lies on the plane. The coefficient of friction between the body and the plane is μ.

(a) Find the normal reaction of the plane on the body. [2]

(b) The body is on the point of slipping down the plane. Find the value of μ. [4]

(c) Calculate the magnitude of the force acting along a line of greatest slope that will move the body up the plane with an acceleration of $0{\cdot}7\,\text{ms}^{-2}$. [4]

(January 12)

6. A particle of mass 3 kg moves in a straight line on a rough horizontal surface. The coefficient of friction between the particle and the surface is $\frac{6}{49}$.

(a) Find the frictional force and show that the deceleration of the particle is $1{\cdot}2\,\text{ms}^{-2}$. [4]

(b) The speed of the particle at the point O is $9\,\text{ms}^{-1}$ and it comes to rest at point A. Calculate the distance OA. [3]

(Summer 12)

7.

An object of mass 75 kg lies on a rough plane, which is inclined at an angle of 25° to the horizontal. The coefficient of friction between the object and the plane is 0·3. A force of magnitude T N acts on the object in a direction parallel to a line of greatest slope of the plane.

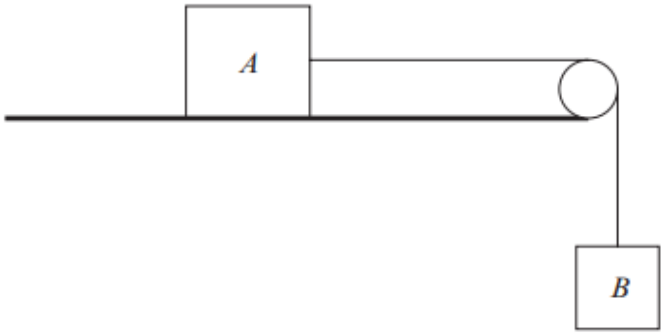
(a) Given that the object is just prevented from sliding down the plane, calculate the value of T. [6]

(b) Given that $T = 0$, find the magnitude of the acceleration of the object. [3]

(January 13)

8.

The diagram shows two bodies A and B, of mass 9 kg and 5 kg respectively, connected by a light inextensible string passing over a smooth light pulley fixed at the edge of a **rough** horizontal table. The heavier body A lies on the table and the lighter body B hangs freely below the pulley.



Initially, the system is held at rest with the string taut. The system is then released.

(a) Given that the magnitude of the acceleration of the bodies is 1·61 ms^{-2}, calculate the tension in the string and the coefficient of friction between A and the table. [8]

(b) Given that the coefficient of friction is 0·6, determine whether the bodies will move or remain at rest and evaluate the tension in the string. [3]

(Summer 13)

9.

An object of mass 60 kg lies on a rough plane inclined at an angle of 25° to the horizontal. The coefficient of friction between the plane and the object is denoted by μ. Initially, the object is held at rest. It is then released.

(a) When $\mu = 0{\cdot}3$, the object slides down the plane. Calculate

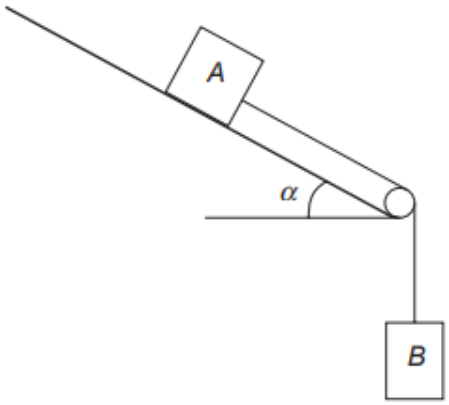
(i) the magnitude of the frictional force,

(ii) the acceleration of the object. [5]

(b) Given that when the object is released it remains stationary, calculate the least possible value of μ. [3]

(January 14)

10. The diagram below shows two objects connected by means of a light inextensible string passing over a smooth light pulley. The pulley is fixed at the bottom of a rough plane inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. Object A, of mass 7 kg, lies on the inclined plane and object B, of mass 3 kg, is hanging freely. The coefficient of friction between the plane and object A is 0·6.



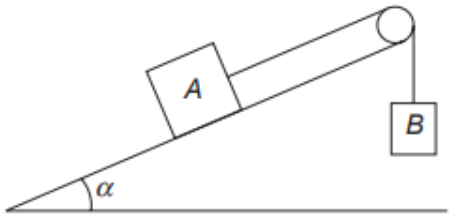
Initially, the objects are held at rest with the string just taut. The objects are then released so that A slides down the plane.

(a) Determine the magnitude of the frictional force acting on A. [3]

(b) Calculate the magnitude of the acceleration of the objects and the tension in the string. [7]

(Summer 14)

11. The diagram shows a body A lying on a rough plane. The plane is inclined at an angle α to the horizontal, where $\sin\alpha = \frac{5}{13}$. Body A is connected by a light inextensible string passing over a light smooth pulley to another body B, which is hanging freely. The masses of A and B are 4 kg and 5 kg respectively.



The system is in equilibrium with A on the point of moving up the plane.

Show that the coefficient of friction between the body A and the plane is $\frac{15}{16}$. [8]

(Summer 15)

12. A sledge of mass 12 kg is being pulled up a rough slope, inclined at an angle of 20° to the horizontal, by a rope which is inclined at an angle of 10° to the slope. The tension in the rope is constant at 80 N. The coefficient of friction between the slope and the sledge is 0·2.

(a) Calculate the frictional force on the sledge. [4]

(b) Determine the magnitude of the acceleration of the sledge. [4]

(Summer 16)

13. An object of mass 45 kg lies on a rough plane inclined at an angle α to the horizontal where $\tan\alpha = \frac{3}{4}$. A rope, attached to the object, is held parallel to the line of greatest slope of the plane. The coefficient of friction between the plane and the object is 0·5. The object remains stationary on the plane. Find the least and the greatest possible values of the tension in the rope. [9]

(Summer 17)