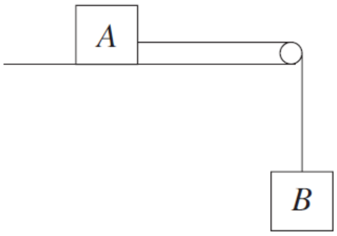
Hen Gwestiynau Arholiad

Friction

(Gaeaf 2006)

4. The diagram shows a body A, of mass 9 kg, connected by a light inextensible string passing over a smooth light pulley to a body B, of mass 5 kg. Body A is on a rough horizontal table and body B is hanging freely. The coefficient of friction between the body A and the table is μ.



(a) If the system is in equilibrium, show that $\mu \geqslant \frac{5}{9}$. [5]

(b) If $\mu = 0{\cdot}5$,

(i) show that the magnitude of the acceleration of the body A is $0{\cdot}35$ ms^{-2} ,

(ii) calculate the tension in the string. [8]

(Haf 2006)

3. A box of mass 20 kg is at rest on a rough horizontal floor. The coefficient of friction between the box and the floor is 0·3. The box is subjected to a horizontal force of T N.

(a) Given that $T = 65$, find the magnitude of the acceleration of the box. [5]

(b) Given that $T = 45$, find the magnitude of the frictional force. [1]

9. A body of mass 15 kg is on a rough plane inclined at an angle of 25° to the horizontal. The coefficient of friction between the body and the plane is 0·4. The body is held at rest by means of a light string, which is parallel to a line of greatest slope of the plane. The magnitude of the tension in the string is T N. Find the greatest and the least possible values of T, giving your answers correct to two decimal places. [9]

(Gaeaf 2007)

5. A body, of mass 80 kg, slides in a straight line with constant deceleration across the horizontal surface of an ice rink. Its initial speed is 9 ms^{-1} and the body travels 75 m before coming to rest.

(a) Calculate the magnitude of the deceleration of the body. [3]

(b) Find the time that elapses before the body comes to rest. [3]

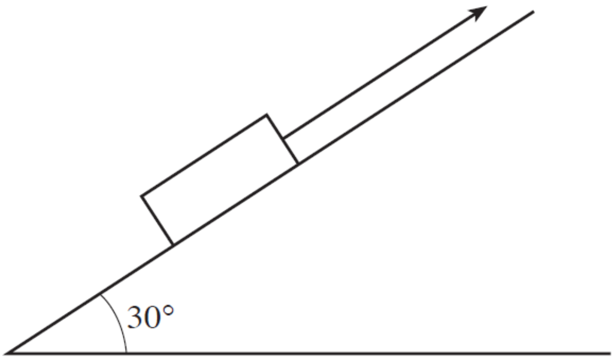
(c) Assuming that the frictional force is the only force acting on the body that has a horizontal component, calculate the coefficient of friction between the body and the surface of the ice rink, giving your answer correct to two significant figures. [5]

(Haf 2007)

6. A **horizontal** force, of magnitude T N, acts on a body of mass 0·8 kg on a rough plane inclined at an angle α to the horizontal, where $\sin\alpha = \frac{3}{5}$. The coefficient of friction between the body and the plane is 0·4. Given that the body is on the point of moving up the plane, calculate the value of T. [8]

(Gaeaf 2008)

3. The diagram shows a sledge on a hill with a rope attached. The hill is modelled as a rough plane inclined at an angle of 30° to the horizontal and the rope is modelled as a light inextensible string parallel to a line of greatest slope of the plane. The sledge is modelled as a particle of mass 15 kg. The coefficient of friction between the sledge and hill is 0·2.



When the tension of the rope is 12 N, the sledge slides **down** the hill. Calculate the magnitude of the acceleration of the sledge, giving your answer correct to one decimal place. [6]

(Haf 2008)

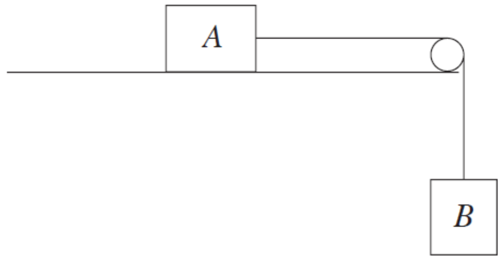
6. An object, of mass 6·5 kg, moves on a slope inclined at an angle α to the horizontal, where $\sin\alpha = \frac{5}{13}$. The coefficient of friction between the object and the slope is $\frac{1}{5}$.

(a) The object is sliding freely down a line of greatest slope. Find the magnitude of the acceleration of the object. [7]

(b) The object is being pulled up the slope at a constant speed by means of a rope parallel to a line of greatest slope. Find the tension in the rope. [4]

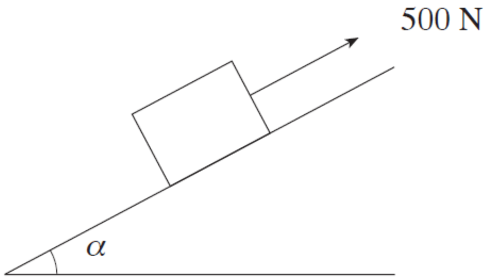
(Gaeaf 2009)

4. The diagram shows an object A, of mass of 4 kg, on a **rough** horizontal table connected by a light inextensible string passing over a smooth light pulley, fixed at the edge of the table, to an object B, of mass 6 kg, hanging freely. The coefficient of friction between the object and the table is 0·3.



Initially, the system is held at rest with the string taut. It is then released. Find the magnitude of the acceleration of A and the tension in the string. [9]

5. The diagram shows a force, of magnitude 500 N, acting on an object, of mass 52 kg, on a rough plane inclined at an angle α to the horizontal, where $\tan\alpha = \dfrac{5}{12}$. The direction of the force is up the plane and parallel to a line of greatest slope. The coefficient of friction between the object and the plane is 0·4.



Calculate the acceleration of the object up the plane. [6]

(Haf 2009)

5. A parcel of mass 8 kg is placed on a rough plane which is inclined at 25° to the horizontal. The coefficient of friction between the parcel and the plane is 0·3. Find the force that must be applied to the parcel in a direction parallel to a line of greatest slope of the plane so that

(a) the parcel is just prevented from sliding down the plane, [6]

(b) the parcel moves up the plane with an acceleration of 0·6 ms^{-2}. [4]

(Gaeaf 2010)

6. 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.

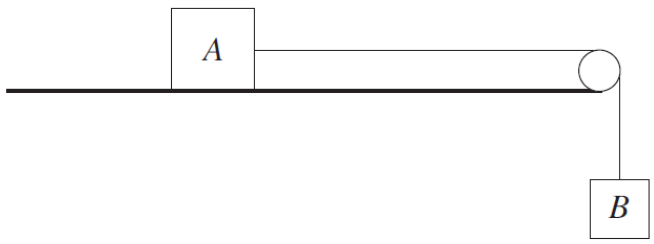
(a) Given that $T = 40$, calculate the magnitude of the frictional force and the acceleration of the object. [5]

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

(Haf 2010)

3. 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]

5. The diagram shows an object A, of mass 6 kg, lying on a rough horizontal table. The object A is connected by means of a <u>light</u> inextensible string passing over a smooth pulley at the edge of the table to another object B, of mass 4 kg, hanging freely.



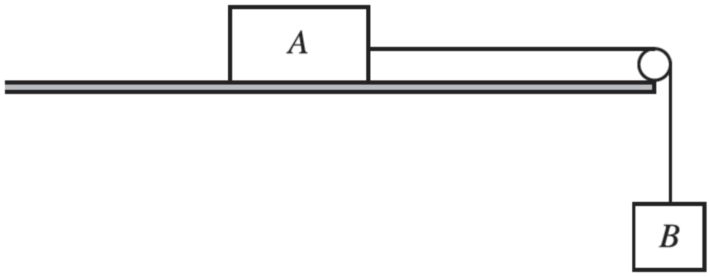
The coefficient of friction between object A and the table is 0·4. Initially, the system is held at rest with the string just taut. The system is then released.

(a) Find the magnitude of the acceleration of object A and the tension in the string. [9]

(b) What assumption did the word 'light' underlined above enable you to make in your solution? [1]

(Gaeaf 2011)

6. 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.



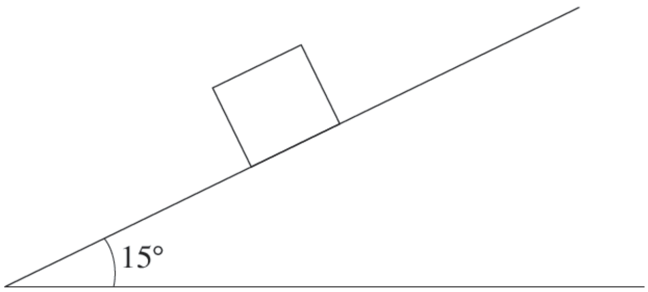
Initially, the system is at rest with the string just taut. The system is then released.

(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]

(Haf 2011)

6. 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]

(Gaeaf 2012)

3. 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]

(Haf 2012)

2. 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]

5. A sledge, of mass 39 kg, moves on a rough slope inclined at an angle α to the horizontal, where $\tan\alpha = \frac{5}{12}$. The coefficient of friction between the sledge and the slope is $0{\cdot}3$.

(a) Given that the sledge is moving freely down a line of greatest slope, calculate the magnitude of the acceleration of the sledge. Give your answer correct to 2 decimal places. [6]

(b) Given that the sledge is being pulled up the slope with acceleration $0{\cdot}4\,\text{ms}^{-2}$ by means of a rope parallel to a line of greatest slope, find the tension in the rope. [3]

(Gaeaf 2013)

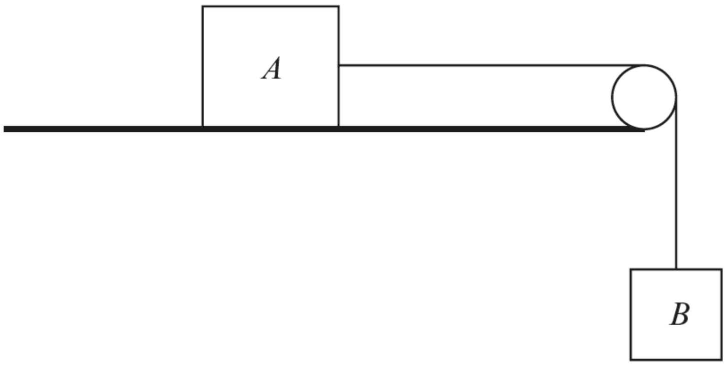
5. An object of mass 75 kg lies on a rough plane, which is inclined at an angle of 25° to the horizontal. The coefficient of friction between the object and the plane is $0{\cdot}3$. A force of magnitude T N acts on the object in a direction parallel to a line of greatest slope of the plane.

(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]

(Haf 2013)

4. 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 $1{\cdot}61\,\text{ms}^{-2}$, 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]

(Gaeaf 2014)

4. 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 μ = 0·3, the object slides down the plane. Calculate

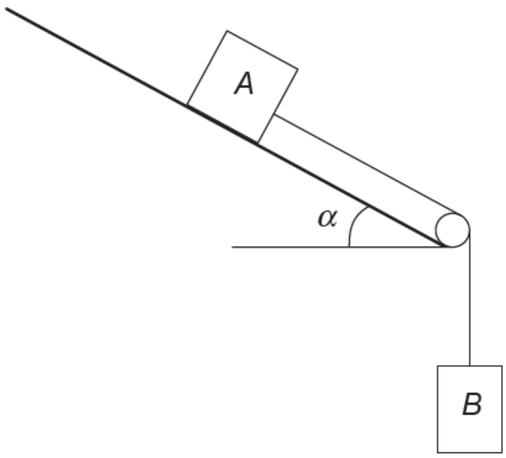
(i) the magnitude of the frictional force,

(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]

(Haf 2014)

3. 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.



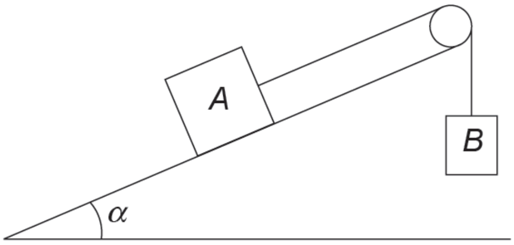
Initially, the objects are held at rest with the string just taut. The objects are then released so that *A* slides down the plane.

(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]

(Haf 2015)

2. 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]

(Haf 2016)

7. 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]

(Haf 2017)

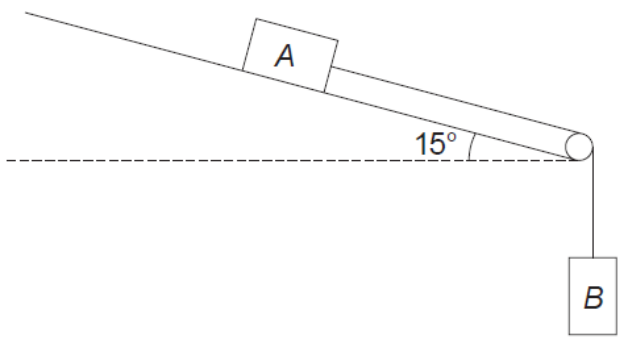
7. An object of mass 45 kg lies on a rough plane inclined at an angle α to the horizontal where $\tan\alpha = \frac{3}{4}$. A rope, attached to the object, is held parallel to the line of greatest slope of the plane. The coefficient of friction between the plane and the object is 0·5. The object remains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

(Haf 2018)

8. A particle of mass 10 kg is at rest on a rough plane inclined at an angle α to the horizontal. When a force of magnitude 98 N, acting **upwards** parallel to a line of greatest slope of the plane, is applied to the particle, it is on the point of moving up the plane. When a force of magnitude 49 N, acting **downwards** parallel to a line of greatest slope of the plane, is applied to the particle, it is on the point of moving down the plane. Find $\sin\alpha$ and the coefficient of friction between the particle and the plane. [9]

(Haf 2019)

6. A light inextensible string connects object *A*, of mass 9 kg, to object *B*, of mass 5 kg. The diagram shows *A* on a plane, inclined at an angle of 15° to the horizontal with the string passing over a smooth light pulley at the edge of the plane so that *B* hangs freely. The coefficient of friction between the object *A* and the plane is μ. Initially, *A* is held at rest with the string just taut. The system is then released from rest.



(a) Given that μ = 0, find the magnitude of the acceleration of *A*, and the tension in the string. [7]

(b) Given that the object *A* remains at rest, find the minimum value of μ. Give your answer correct to two decimal places. [6]