Bronze Question 1

A block of mass 10 kg is pulled along a straight horizontal road by a constant horizontal force of magnitude 70 N in the direction of the road. The block moves in a straight line passing through two points A and B on the road, where $AB = 50$ m. The block is modelled as a particle and the road is modelled as a rough plane. The coefficient of friction between the block and the road is $\frac{4}{7}$

(a) Calculate the work done against friction in moving the block from A to B.

(4)

The block passes through A with a speed of 2 m s^{-1}.

(b) Find the speed of the block at B.

(4)
(Total 8 marks)

Bronze Question 2

A particle P of mass 0.6 kg is released from rest and slides down a line of greatest slope of a rough plane. The plane is inclined at 30° to the horizontal. When P has moved 12 m, its speed is 4 m s^{-1}. Given that friction is the only non-gravitational resistive force acting on P, find

(a) the work done against friction as the speed of P increases from 0 ms^{-1} to 4 ms^{-1},

(4)

(b) the coefficient of friction between the particle and the plane.

(4)
(Total 8 marks)

Bronze Question 3

A car of mass 1500 kg is moving up a straight road, which is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{1}{14}$. The resistance to the motion of the car from non-gravitational forces is constant and is modelled as a single constant force of magnitude 650 N. The car's engine is working at a rate of 30 kW.

Find the acceleration of the car at the instant when its speed is 15 m s^{-1}.

(Total 5 marks)

Silver Question 1

A particle P of mass 0.6 kg is released from rest and slides down a line of greatest slope of a rough plane. The plane is inclined at 30° to the horizontal. When P has moved 12 m, its speed is 4 m s^{-1}. Given that friction is the only non-gravitational resistive force acting on P, find

(a) the work done against friction as the speed of P increases from 0 ms^{-1} to 4 ms^{-1},

(4)

(b) the coefficient of friction between the particle and the plane.

(4)
(Total 8 marks)

Silver Question 2

A particle P has mass 4 kg. It is projected from a point A up a line of greatest slope of a rough plane inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. The coefficient of friction between P and the plane is $\frac{2}{7}$. The particle comes to rest instantaneously at the point B on the plane, where AB = 2.5 m. It then moves back down the plane to A.

(a) Find the work done by friction as P moves from A to B.

(4)

(b) Using the work-energy principle, find the speed with which P is projected from A.

(4)

(c) Find the speed of P when it returns to A.

(4)
(Total 12 marks)

Silver Question 3

A car of mass 1000 kg is moving along a straight horizontal road. The resistance to motion is modelled as a constant force of magnitude R newtons. The engine of the car is working at a rate of 12 kW. When the car is moving with speed 15 m s^{-1}, the acceleration of the car is 0.2 m s^{-2}.

(a) Show that $R = 600$.

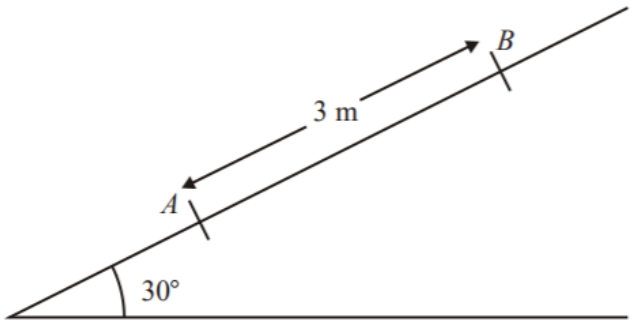
(4)

The car now moves with constant speed U m s^{-1} downhill on a straight road inclined at θ to the horizontal, where $\sin\theta = \frac{1}{40}$. The engine of the car is now working at a rate of 7 kW. The resistance to motion from non-gravitational forces remains of magnitude R newtons.

(b) Calculate the value of U.

(5)
(Total 9 marks)

Gold Question 1



A particle P of mass 2 kg is projected from a point A up a line of greatest slope AB of a fixed plane. The plane is inclined at an angle of 30° to the horizontal and $AB = 3$ m with B above A, as shown in the diagram above. The speed of P at A is 10 m s^{-1}.

Assuming the plane is smooth,

(a) find the speed of P at B.

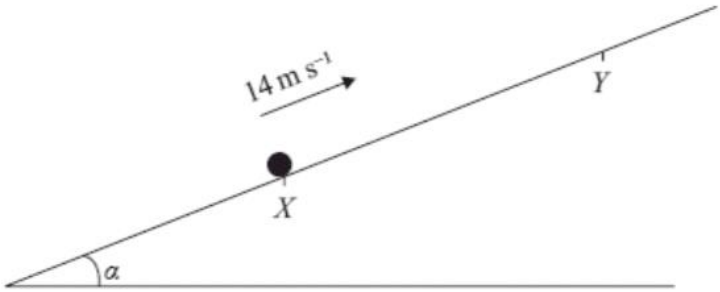
(4)

The plane is now assumed to be rough. At A the speed of P is 10 m s^{-1} and at B the speed of P is 7 m s^{-1}. By using the work-energy principle, or otherwise,

(b) find the coefficient of friction between P and the plane.

(5)
(Total 9 marks)

Gold Question 2



A particle P of mass 2 kg is projected up a rough plane with initial speed 14 m s^{-1}, from a point X on the plane, as shown in the diagram above. The particle moves up the plane along the line of greatest slope through X and comes to instantaneous rest at the point Y. The plane is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{7}{24}$. The coefficient of friction between the particle and the plane is $\frac{1}{8}$.

(a) Use the work-energy principle to show that $XY = 25$ m.

(7)

After reaching Y, the particle P slides back down the plane.

(b) Find the speed of P as it passes through X.

(4)
(Total 11 marks)

Gold Question 3

The resistance to the motion of a cyclist is modelled as kv^2 N, where k is a constant and v m s^{-1} is the speed of the cyclist. The total mass of the cyclist and his bicycle is 100 kg. The cyclist freewheels down a slope inclined at an angle α to the horizontal, where $\sin \alpha = \frac{1}{20}$, at a constant speed of 3.5 m s^{-1}.

(a) Show that $k = 4$.

(3)

The cyclist ascends a slope inclined at an angle β to the horizontal, where $\sin \beta = \frac{1}{40}$, at a constant speed of 2 m s^{-1}.

(b) Find the rate at which the cyclist is working.

(6)
(Total 9 marks)