Newton's Laws of Motion – 2022 June AS

1. March/2022/Paper_9709/42/No.4

The total mass of a cyclist and her bicycle is 70 kg. The cyclist is riding with constant power of 180 W up a straight hill inclined at an angle α to the horizontal, where $\sin\alpha = 0.05$. At an instant when the cyclist's speed is $6\,\text{m s}^{-1}$, her acceleration is $-0.2\,\text{m s}^{-2}$. There is a constant resistance to motion of magnitude F N.

(a) Find the value of F. [4]

(b) Find the steady speed that the cyclist could maintain up the hill when working at this power. [2]

2. June/2022/Paper_9709/41/No.2

Two particles P and Q, of masses 0.5 kg and 0.3 kg respectively, are connected by a light inextensible string. The string is taut and P is vertically above Q. A force of magnitude 10 N is applied to P vertically upwards.

Find the acceleration of the particles and the tension in the string connecting them. [5]

3. June/2022/Paper_9709/41/No.3

A crate of mass 300 kg is at rest on rough horizontal ground. The coefficient of friction between the crate and the ground is 0.5. A force of magnitude X N, acting at an angle α above the horizontal, is applied to the crate, where $\sin\alpha = 0.28$.

Find the greatest value of X for which the crate remains at rest. [5]

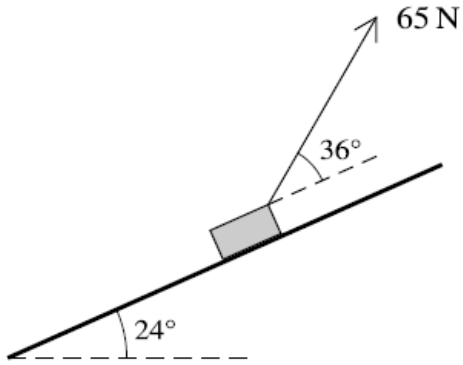
4. June/2022/Paper_9709/42/No.3

Two particles A and B, of masses 2.4 kg and 1.2 kg respectively, are connected by a light inextensible string which passes over a fixed smooth pulley. A is held at a distance of 2.1 m above a horizontal plane and B is 1.5 m above the plane. The particles hang vertically and are released from rest. In the subsequent motion A reaches the plane and does not rebound and B does not reach the pulley.

(a) Show that the tension in the string before A reaches the plane is 16 N and find the magnitude of the acceleration of the particles before A reaches the plane. [4]

(b) Find the greatest height of B above the plane. [3]

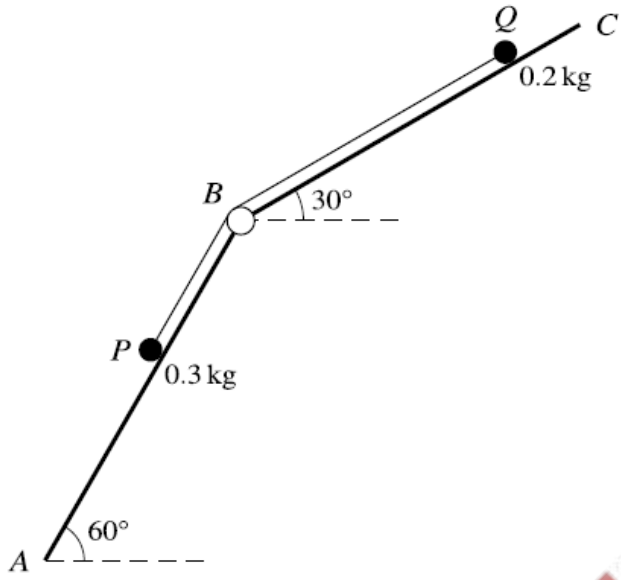
5. June/2022/Paper_9709/42/No.5



A block of mass 12 kg is placed on a plane which is inclined at an angle of 24° to the horizontal. A light string, making an angle of 36° above a line of greatest slope, is attached to the block. The tension in the string is 65 N (see diagram). The coefficient of friction between the block and plane is μ. The block is in limiting equilibrium and is on the point of sliding up the plane.

Find μ. [6]

6. June/2022/Paper_9709/43/No.6



Two particles P and Q, of masses 0.3 kg and 0.2 kg respectively, are attached to the ends of a light inextensible string. The string passes over a fixed smooth pulley at B which is attached to two inclined planes. P lies on a smooth plane AB which is inclined at 60° to the horizontal. Q lies on a plane BC which is inclined at 30° to the horizontal. The string is taut and the particles can move on lines of greatest slope of the two planes (see diagram).

(a) It is given that the plane BC is smooth and that the particles are released from rest.

Find the tension in the string and the magnitude of the acceleration of the particles. [5]

(b) It is given instead that the plane BC is rough. A force of magnitude 3 N is applied to Q directly up the plane along a line of greatest slope of the plane.

Find the least value of the coefficient of friction between Q and the plane BC for which the particles remain at rest. [5]