1. March/2022/Paper_9709/42/No.7

A bead, A, of mass 0.1 kg is threaded on a long straight rigid wire which is inclined at $\sin^{-1}\left(\frac{7}{25}\right)$ to the horizontal. A is released from rest and moves down the wire. The coefficient of friction between A and the wire is μ. When A has travelled 0.45 m down the wire, its speed is 0.6 m s^{-1}.

(a) Show that $\mu = 0.25$. [6]

Another bead, B, of mass 0.5 kg is also threaded on the wire. At the point where A has travelled 0.45 m down the wire, it hits B which is instantaneously at rest on the wire. A is brought to instantaneous rest in the collision. The coefficient of friction between B and the wire is 0.275.

(b) Find the time from when the collision occurs until A collides with B again. [6]

2. June/2022/Paper_9709/41/No.7

Two particles A and B, of masses 0.4 kg and 0.2 kg respectively, are moving down the same line of greatest slope of a smooth plane. The plane is inclined at 30° to the horizontal, and A is higher up the plane than B. When the particles collide, the speeds of A and B are $3\,m\,s^{-1}$ and $2\,m\,s^{-1}$ respectively. In the collision between the particles, the speed of A is reduced to $2.5\,m\,s^{-1}$.

(a) Find the speed of B immediately after the collision. [2]

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After the collision, when B has moved 1.6 m down the plane from the point of collision, it hits a barrier and returns back up the same line of greatest slope. B hits the barrier 0.4 s after the collision, and when it hits the barrier, its speed is reduced by 90%. The two particles collide again 0.44 s after their previous collision, and they then coalesce on impact.

(b) Show that the speed of B immediately after it hits the barrier is $0.5\,m\,s^{-1}$. Hence find the speed of the combined particle immediately after the second collision between A and B. [7]

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3. June/2022/Paper_9709/42/No.1

Small smooth spheres A and B, of equal radii and of masses 5 kg and 3 kg respectively, lie on a smooth horizontal plane. Initially B is at rest and A is moving towards B with speed $8.5\,\text{m s}^{-1}$. The spheres collide and after the collision A continues to move in the same direction but with a quarter of the speed of B.

(a) Find the speed of B after the collision. [3]

(b) Find the loss of kinetic energy of the system due to the collision. [2]

4. June/2022/Paper_9709/43/No.1

Two particles P and Q, of masses 0.3 kg and 0.2 kg respectively, are at rest on a smooth horizontal plane. P is projected at a speed of $4\,\text{m s}^{-1}$ directly towards Q. After P and Q collide, Q begins to move with a speed of $3\,\text{m s}^{-1}$.

(a) Find the speed of P after the collision. [2]

After the collision, Q moves directly towards a third particle R, of mass m kg, which is at rest on the plane. The two particles Q and R coalesce on impact and move with a speed of $2\,\text{m s}^{-1}$.

(b) Find m. [2]