

Coefficient of Restitution (From OCR 4729)

Q1, (Jan 2007, Q2)

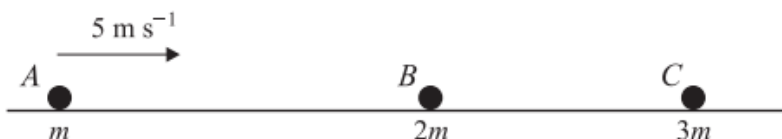
Two smooth spheres A and B , of equal radius and of masses 0.2 kg and 0.1 kg respectively, are free to move on a smooth horizontal table. A is moving with speed 4 m s^{-1} when it collides directly with B , which is stationary. The collision is perfectly elastic. Calculate the speed of A after the impact. [4]

Q2, (Jan 2007, Q4)

A small sphere of mass 0.2 kg is projected vertically downwards with speed 21 m s^{-1} from a point at a height of 40 m above horizontal ground. It hits the ground and rebounds vertically upwards, coming to instantaneous rest at its initial point of projection. Ignoring air resistance, calculate

- (i) the coefficient of restitution between the sphere and the ground, [6]
- (ii) the magnitude of the impulse which the ground exerts on the sphere. [2]

Q3, (Jun 2005, Q4)



Three smooth spheres A , B and C , of equal radius and of masses m kg, $2m$ kg and $3m$ kg respectively, lie in a straight line and are free to move on a smooth horizontal table. Sphere A is moving with speed 5 m s^{-1} when it collides directly with sphere B which is stationary. As a result of the collision B starts to move with speed 2 m s^{-1} .

- (i) Find the coefficient of restitution between A and B . [4]
- (ii) Find, in terms of m , the magnitude of the impulse that A exerts on B , and state the direction of this impulse. [2]

Sphere B subsequently collides with sphere C which is stationary. As a result of this impact B and C coalesce.

- (iii) Show that there will be another collision. [3]

Q4, (Jun 2006, Q8)

Two uniform smooth spheres, A and B , have the same radius. The mass of A is 2 kg and the mass of B is m kg. Sphere A is travelling in a straight line on a smooth horizontal surface, with speed 5 m s^{-1} , when it collides directly with sphere B , which is at rest. As a result of the collision, sphere A continues in the same direction with a speed of 2 m s^{-1} .

- (i) Find the greatest possible value of m . [3]

It is given that $m = 1$.

- (ii) Find the coefficient of restitution between A and B . [3]

On another occasion A and B are travelling towards each other, each with speed 5 m s^{-1} , when they collide directly.

- (iii) Find the kinetic energy lost due to the collision. [8]

Q5, (Jun 2009, Q6)

Two uniform spheres, A and B , have the same radius. The mass of A is 0.4 kg and the mass of B is 0.2 kg . The spheres A and B are travelling in the same direction in a straight line on a smooth horizontal surface, A with speed 5 m s^{-1} , and B with speed $v\text{ m s}^{-1}$, where $v < 5$. A collides directly with B and the impulse between them has magnitude 0.9 N s . Immediately after the collision, the speed of B is 6 m s^{-1} .

- (i) Calculate v . [3]

B subsequently collides directly with a stationary sphere C of mass 0.1 kg and the same radius as A and B . The coefficient of restitution between B and C is 0.6 .

- (ii) Determine whether there will be a further collision between A and B . [10]

Q6, (Jan 2011, Q7)

Three small smooth spheres A , B and C of masses 0.2 kg , 0.7 kg and $m\text{ kg}$ respectively are free to move in a straight line on a smooth horizontal table. Initially B and C are stationary and A is moving with velocity 1.8 m s^{-1} directly towards B . The coefficient of restitution for the collision between A and B is e . Immediately after this collision the speed of A is greater than the speed of B .

- (i) Calculate the set of possible values of e . [9]

It is now given that the speed of B immediately after the collision with A is 0.75 m s^{-1} . B continues its motion and strikes C directly in a perfectly elastic collision. B has speed 0.25 m s^{-1} immediately after its collision with C .

- (ii) Calculate the two possible values of m . [6]

Q7, (Jan 2013, Q3)

A particle A is released from rest from the top of a smooth plane, which makes an angle of 30° with the horizontal. The particle A collides 2 s later with a particle B , which is moving up a line of greatest slope of the plane. The coefficient of restitution between the particles is 0.4 and the speed of B immediately before the collision is 2 m s^{-1} . B has velocity 1 m s^{-1} down the plane immediately after the collision. Find

- (i) the speed of A immediately after the collision, [4]

- (ii) the distance A moves up the plane after the collision. [2]

The masses of A and B are 0.5 kg and $m\text{ kg}$, respectively.

- (iii) Find the value of m . [3]

Q8, (Jun 2014, Q6)

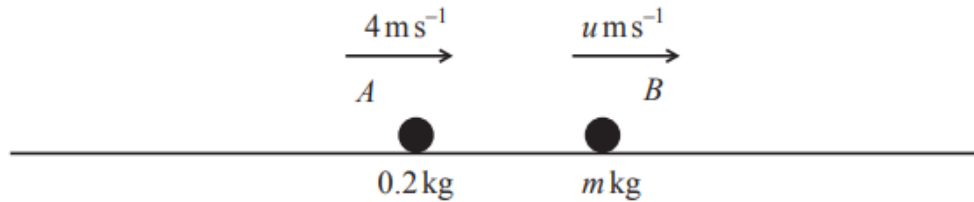
Two small spheres A and B , of masses $2m\text{ kg}$ and $3m\text{ kg}$ respectively, are moving in opposite directions along the same straight line towards each other on a smooth horizontal surface. A has speed 4 m s^{-1} and B has speed 2 m s^{-1} before they collide. The coefficient of restitution between A and B is 0.4 .

- (i) Find the speed of each sphere after the collision. [6]

- (ii) Find, in terms of m , the loss of kinetic energy during the collision. [4]

- (iii) Given that the magnitude of the impulse exerted on A by B during the collision is 2.52 N s , find m . [3]

Q9, (Jun 2013, Q6)



The masses of two particles A and B are 0.2 kg and $m \text{ kg}$ respectively. The particles are moving with constant speeds 4 m s^{-1} and $u \text{ m s}^{-1}$ in the same horizontal line and in the same direction (see diagram). The two particles collide and the coefficient of restitution between the particles is e . After the collision, A and B continue in the same direction with speeds $4(1 - e + e^2) \text{ m s}^{-1}$ and 4 m s^{-1} respectively.

- (i) Find u and m in terms of e . [6]
- (ii) Find the value of e for which the speed of A after the collision is least and find, in this case, the total loss in kinetic energy due to the collision. [5]
- (iii) Find the possible values of e for which the magnitude of the impulse that B exerts on A is 0.192 N s . [4]

Q10, (Jun 2015, Q5)

A small sphere of mass 0.2 kg is projected vertically downwards with a speed of 5 m s^{-1} from a height of 1.6 m above horizontal ground. It hits the ground and rebounds vertically upwards coming to instantaneous rest at a height of $h \text{ m}$ above the ground. The coefficient of restitution between the sphere and the ground is 0.7 .

- (i) Find h . [4]
- (ii) Find the magnitude and direction of the impulse exerted on the sphere by the ground. [3]
- (iii) Find the loss of energy of the sphere between the instant of projection and the instant it comes to instantaneous rest at height $h \text{ m}$. [3]

Q11, (Jun 2016, Q6)

The masses of two particles A and B are 4 kg and 3 kg respectively. The particles are moving towards each other along a straight line on a smooth horizontal surface. A has speed 8 m s^{-1} and B has speed 10 m s^{-1} before they collide. The kinetic energy lost due to the collision is 121.5 J .

- (i) Find the speed and direction of motion of each particle after the collision. [8]
- (ii) Find the coefficient of restitution between A and B . [2]