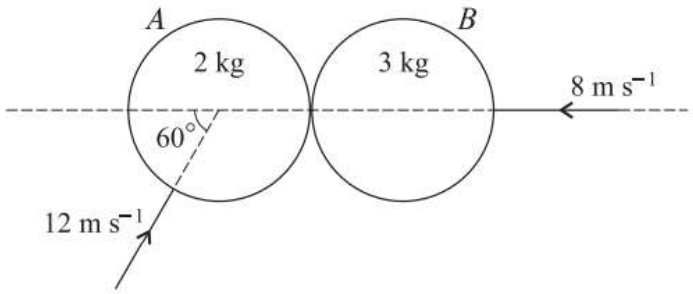
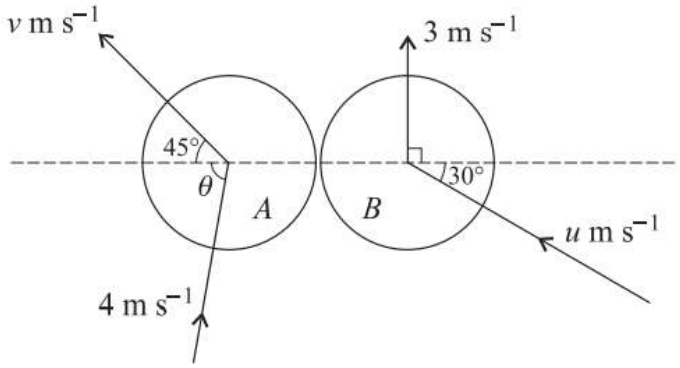
Oblique Collisions (From OCR 4730)

Q1, (Jun 2006, Q5)



Two uniform smooth spheres A and B, of equal radius, have masses 2 kg and 3 kg respectively. They are moving on a horizontal surface when they collide. Immediately before the collision A is moving with speed $12\,\text{m s}^{-1}$ at 60° to the line of centres, and B is moving with speed $8\,\text{m s}^{-1}$ along the line of centres (see diagram). The coefficient of restitution between the spheres is 0.5. Find the speed and direction of motion of each sphere after the collision. [12]

Q2, (Jan 2007, Q6)



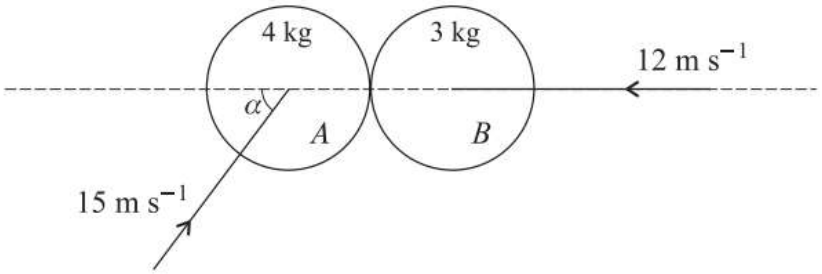
Two uniform smooth spheres A and B of equal radius are moving on a horizontal surface when they collide. A has mass 0.4 kg, and B has mass m kg. Immediately before the collision, A is moving with speed $4\,\text{m s}^{-1}$ at an acute angle θ to the line of centres, and B is moving with speed $u\,\text{m s}^{-1}$ at 30° to the line of centres. Immediately after the collision A is moving with speed $v\,\text{m s}^{-1}$ at 45° to the line of centres, and B is moving with speed $3\,\text{m s}^{-1}$ perpendicular to the line of centres (see diagram).

(i) Find u. [2]

(ii) Given that $\theta = 88.1°$ correct to 1 decimal place, calculate the approximate values of v and m. [5]

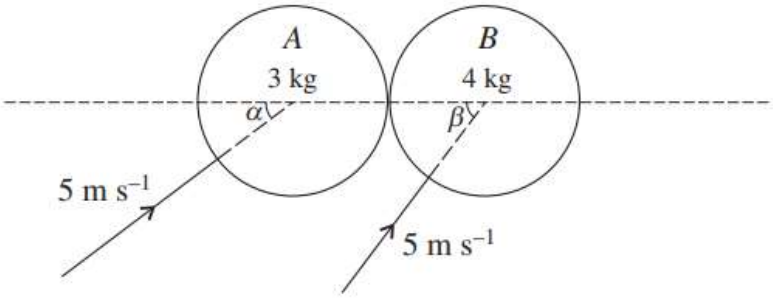
(iii) The coefficient of restitution is 0.75. Show that the exact value of θ is a root of the equation $8\sin\theta - 6\cos\theta = 9\cos 30°$. [5]

Q3, (Jun 2007, Q4)



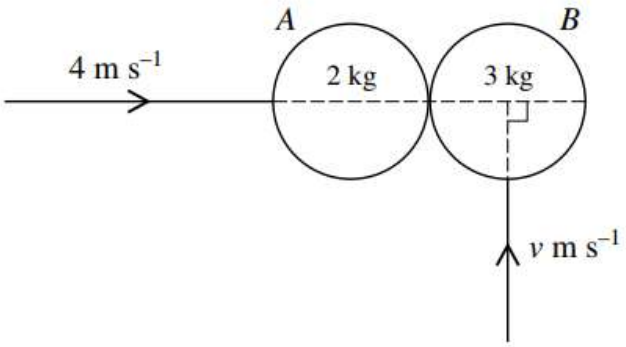
Two uniform smooth spheres A and B, of equal radius, have masses 4 kg and 3 kg respectively. They are moving on a horizontal surface, and they collide. Immediately before the collision, A is moving with speed 15 m s^{-1} at an angle α to the line of centres, where $\sin\alpha = 0.8$, and B is moving along the line of centres with speed 12 m s^{-1} (see diagram). The coefficient of restitution between the spheres is 0.5. Find the speed and direction of motion of each sphere after the collision. [10]

Q4, (Jan 2009, Q5)



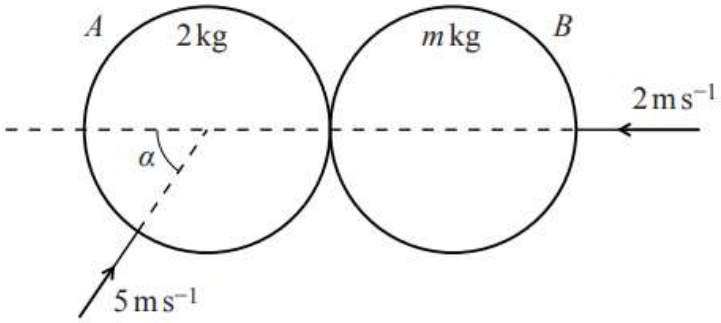
Two smooth uniform spheres A and B, of equal radius, have masses 3 kg and 4 kg respectively. They are moving on a horizontal surface, each with speed 5 m s^{-1}, when they collide. The directions of motion of A and B make angles α and β respectively with the line of centres of the spheres, where $\sin\alpha = \cos\beta = 0.6$ (see diagram). The coefficient of restitution between the spheres is 0.75. Find the angle that the velocity of A makes, immediately after impact, with the line of centres of the spheres. **[10]**

Q5, (Jan 2010, Q2)



Two uniform smooth spheres A and B, of equal radius, have masses 2 kg and 3 kg respectively. They are moving on a horizontal surface when they collide. Immediately before the collision, A has speed 4 m s^{-1} and is moving along the line of centres, and B has speed v m s^{-1} and is moving perpendicular to the line of centres (see diagram). The coefficient of restitution is 0.6. The direction of motion of B after the collision makes an angle of 45° with the line of centres. Find the value of v. **[7]**

Q6, (Jun 2012, Q6)



Two smooth uniform spheres A and B, of equal radius, have masses 2 kg and m kg respectively. They are moving on a horizontal surface when they collide. Immediately before the collision, A has speed $5\,\text{m s}^{-1}$ and is moving towards B at an angle of α to the line of centres, where $\cos\alpha = 0.6$. B has speed $2\,\text{m s}^{-1}$ and is moving towards A along the line of centres (see diagram). As a result of the collision, A's loss of kinetic energy is 7.56 J, B's direction of motion is reversed and B's speed after the collision is $0.8\,\text{m s}^{-1}$. Find

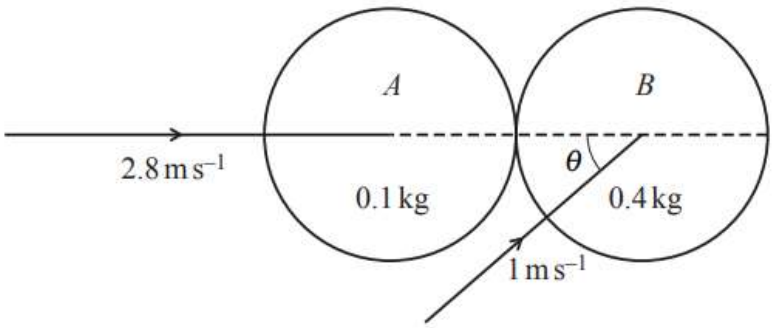
(i) the speed of A after the collision, **[3]**

(ii) the component of A's velocity after the collision, parallel to the line of centres, stating with a reason whether its direction is to the left or to the right, **[3]**

(iii) the value of m, **[3]**

(iv) the coefficient of restitution between A and B. **[2]**

Q7, (Jun 2014, Q3)

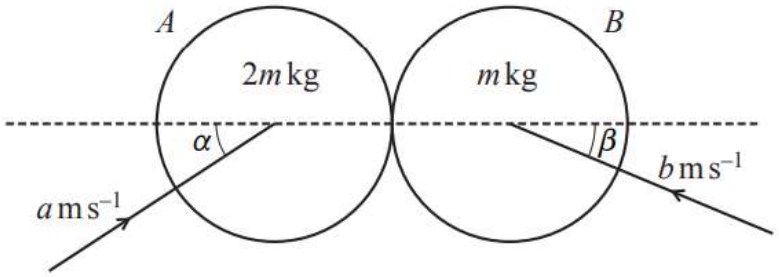


Two uniform smooth spheres A and B of equal radius are moving on a horizontal surface when they collide. A has mass 0.1 kg and B has mass 0.4 kg. Immediately before the collision A is moving with speed $2.8\,\text{m s}^{-1}$ along the line of centres, and B is moving with speed $1\,\text{m s}^{-1}$ at an angle θ to the line of centres, where $\cos\theta = 0.8$ (see diagram). Immediately after the collision A is stationary. Find

(i) the coefficient of restitution between A and B, **[5]**

(ii) the angle turned through by the direction of motion of B as a result of the collision. **[4]**

Q8, (Jun 2015, Q5)

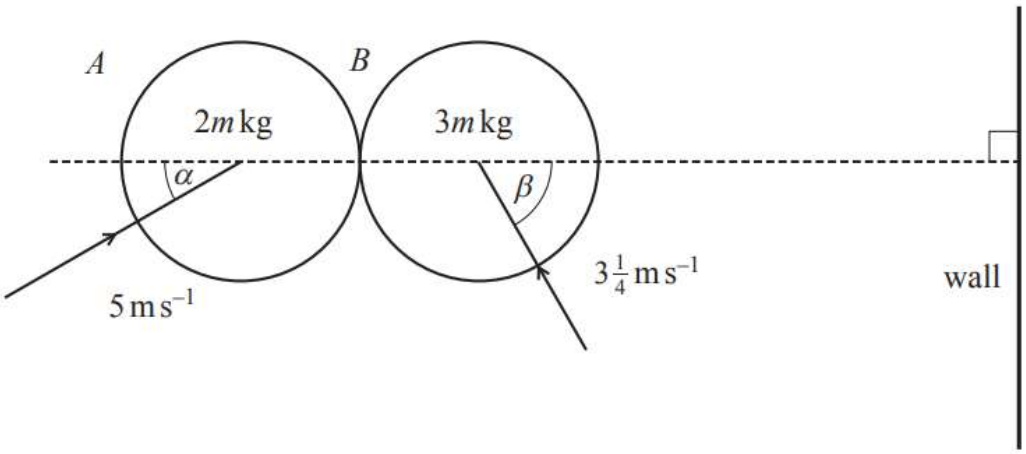


Two uniform smooth spheres A and B, of equal radius, have masses $2m$ kg and m kg respectively. The spheres are moving on a horizontal surface when they collide. Before the collision, A is moving with speed $a\,\text{m s}^{-1}$ in a direction making an angle α with the line of centres and B is moving towards A with speed $b\,\text{m s}^{-1}$ in a direction making an angle β with the line of centres (see diagram). After the collision, A moves with velocity $2\,\text{m s}^{-1}$ in a direction perpendicular to the line of centres and B moves with velocity $2\,\text{m s}^{-1}$ in a direction making an angle of 45° with the line of centres. The coefficient of restitution between A and B is $\frac{2}{3}$.

(i) Show that $a\cos\alpha = \frac{5}{6}\sqrt{2}$ and find $b\cos\beta$. **[7]**

(ii) Find the values of a and α. **[4]**

Q9, (Jun 2016, Q3)



Two uniform smooth spheres A and B, of equal radius, have masses $2m$ kg and $3m$ kg respectively. The spheres are approaching each other on a horizontal surface when they collide. Before the collision A is moving with speed $5\,\text{m s}^{-1}$ in a direction making an angle α with the line of centres, where $\cos\alpha = \frac{4}{5}$, and B is moving with speed $3\frac{1}{4}\,\text{m s}^{-1}$ in a direction making an angle β with the line of centres, where $\cos\beta = \frac{5}{13}$. A straight vertical wall is situated to the right of B, perpendicular to the line of centres (see diagram). The coefficient of restitution between A and B is $\frac{2}{3}$.

(i) Find the speed of A after the collision. Find also the component of the velocity of B along the line of centres after the collision. **[7]**

B subsequently hits the wall.

(ii) Explain why A and B will have a second collision if the coefficient of restitution between B and the wall is sufficiently large. Find the set of values of the coefficient of restitution for which this second collision will occur. **[3]**
