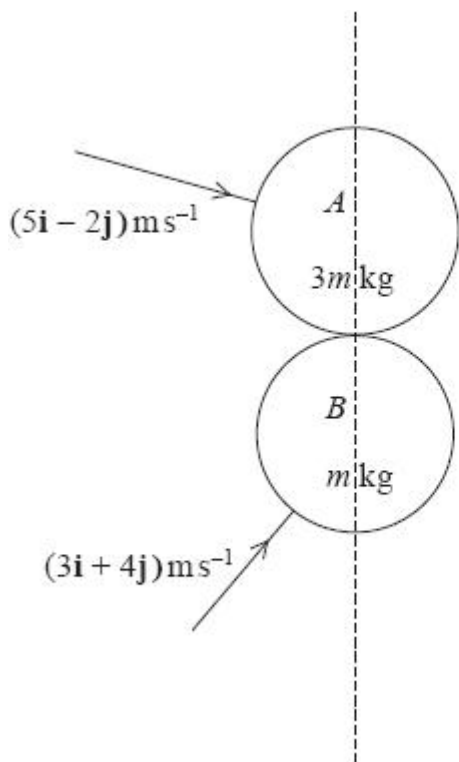




**Oblique Collisions With Vectors Exam Questions (Edexcel)**

Q1.



Two smooth uniform spheres  $A$  and  $B$  have masses  $3m$  kg and  $m$  kg respectively and equal radii. The spheres are moving on a smooth horizontal surface. Initially, sphere  $A$  has velocity  $(5\mathbf{i} - 2\mathbf{j})\text{ms}^{-1}$  and sphere  $B$  has velocity  $(3\mathbf{i} + 4\mathbf{j})\text{ms}^{-1}$ . When the spheres collide, the line joining their centres is parallel to  $\mathbf{j}$ , as shown in Figure 1.

The coefficient of restitution between the two spheres is  $e$ .

The kinetic energy of sphere  $B$  immediately after the collision is 85% of its kinetic energy immediately before the collision.

Find

(a) the velocity of each sphere immediately after the collision,

(9)

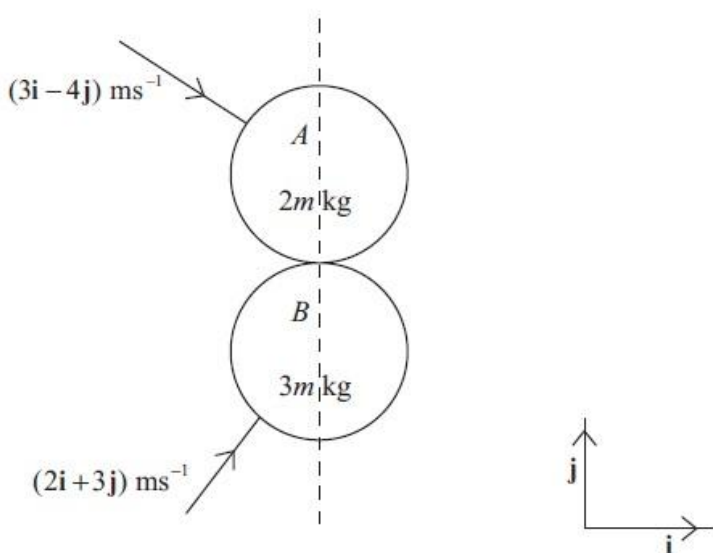
(b) the value of  $e$ .

(3)

(Total for question = 12 marks)

(Q05 6680/01, June 2017)

Q2.



Two smooth uniform spheres  $A$  and  $B$  have masses  $2m$  kg and  $3m$  kg respectively and equal radii. The spheres are moving on a smooth horizontal surface. Initially, sphere  $A$  has velocity  $(3\mathbf{i} - 4\mathbf{j})\text{ms}^{-1}$  and sphere  $B$  has velocity  $(2\mathbf{i} + 3\mathbf{j})\text{ms}^{-1}$ . When the spheres collide, the line joining their centres is parallel to  $\mathbf{j}$ , as shown in Figure 1. The coefficient of

restitution between the spheres is  $\frac{3}{7}$ . Find, in terms of  $m$ , the total kinetic energy lost in the collision.

(10)

(Total 10 marks)

(Q07 6680/01, June 2011)

Figure 1



**Q3.**

[In this question  $\mathbf{i}$  and  $\mathbf{j}$  are perpendicular unit vectors in a horizontal plane]

A small smooth ball of mass  $m$  kg is moving on a smooth horizontal plane and strikes a fixed smooth vertical wall. The plane and the wall intersect in a straight line which is parallel to the vector  $2\mathbf{i} + \mathbf{j}$ . The velocity of the ball immediately before the impact is  $b\mathbf{i}$  m s<sup>-1</sup>, where  $b$  is positive. The velocity of the ball immediately after the impact is  $a(\mathbf{i} + \mathbf{j})$  m s<sup>-1</sup>, where  $a$  is positive.

(a) Show that the impulse received by the ball when it strikes the wall is parallel to  $(-\mathbf{i} + 2\mathbf{j})$ .

(1)

Find

(b) the coefficient of restitution between the ball and the wall,

(8)

(c) the fraction of the kinetic energy of the ball that is lost due to the impact.

(3)

**(Total 12 marks)**

**(Q06 6680/01, June 2013)**

**Q4.**

A smooth uniform sphere  $A$  has mass  $2m$  kg and another smooth uniform sphere  $B$ , with the same radius as  $A$ , has mass  $m$  kg. The spheres are moving on a smooth horizontal plane when they collide. At the instant of collision the line joining the centres of the spheres is parallel to  $\mathbf{j}$ . Immediately **after** the collision, the velocity of  $A$  is  $(3\mathbf{i} - \mathbf{j})$  m s<sup>-1</sup> and the velocity of  $B$  is  $(2\mathbf{i} + \mathbf{j})$  m s<sup>-1</sup>. The coefficient of restitution between the spheres is  $\frac{1}{2}$ .

(a) Find the velocities of the two spheres immediately before the collision.

(7)

(b) Find the magnitude of the impulse in the collision.

(2)

(c) Find, to the nearest degree, the angle through which the direction of motion of  $A$  is deflected by the collision.

(4)

**(Total 13 marks)**

**(Q06 6680/01, June 2007)**

**Q5.**

Two small smooth spheres  $A$  and  $B$  have equal radii. The mass of  $A$  is  $2m$  kg and the mass of  $B$  is  $m$  kg. The spheres are moving on a smooth horizontal plane and they collide. Immediately before the collision the velocity of  $A$  is  $(2\mathbf{i} - 2\mathbf{j})$  m s<sup>-1</sup> and the velocity of  $B$  is  $(-3\mathbf{i} - \mathbf{j})$  m s<sup>-1</sup>. Immediately after the collision the velocity of  $A$  is  $(\mathbf{i} - 3\mathbf{j})$  m s<sup>-1</sup>.

Find the speed of  $B$  immediately after the collision.

(5)

**(Total 5 marks)**

**(Q05 6680/01, June 2008)**



**Q6.**

Two small smooth spheres  $A$  and  $B$ , of mass 2 kg and 1 kg respectively, are moving on a smooth horizontal plane when they collide. Immediately before the collision the velocity of  $A$  is  $(\mathbf{i} + 2\mathbf{j}) \text{ m s}^{-1}$  and the velocity of  $B$  is  $-2\mathbf{i} \text{ m s}^{-1}$ . Immediately after the collision the velocity of  $A$  is  $\mathbf{j} \text{ m s}^{-1}$ .

(a) Show that the velocity of  $B$  immediately after the collision is  $2\mathbf{j} \text{ m s}^{-1}$ . (3)

(b) Find the impulse of  $B$  on  $A$  in the collision, giving your answer as a vector, and hence show that the line of centres is parallel to  $\mathbf{i} + \mathbf{j}$ . (4)

(c) Find the coefficient of restitution between  $A$  and  $B$ . (6)

(Total 13 marks)

(Q07 6680/01, June 2009)

**Q7.**

*[In this question,  $\mathbf{i}$  and  $\mathbf{j}$  are horizontal perpendicular unit vectors.]*

A particle  $P$  is moving with velocity  $(4\mathbf{i} - \mathbf{j}) \text{ m s}^{-1}$  on a smooth horizontal plane.

The particle collides with a smooth vertical wall and rebounds with velocity  $(\mathbf{i} + 3\mathbf{j}) \text{ m s}^{-1}$

The coefficient of restitution between  $P$  and the wall is  $e$ .

(a) Find the value of  $e$ . (6)

After the collision,  $P$  goes on to hit a second smooth vertical wall, which is parallel to  $\mathbf{i}$ .

The coefficient of restitution between  $P$  and this second wall is  $\frac{1}{3}$

The angle through which the direction of motion of  $P$  has been deflected by its collision with this second wall is  $\alpha^\circ$ .

(b) Find the value of  $\alpha$ , giving your answer to the nearest whole number. (4)

(Total for question = 10 marks)

(Q06 9FM0/03C, June 2024)



**Q8.**

[In this question  $\mathbf{i}$  and  $\mathbf{j}$  are perpendicular unit vectors in a horizontal plane.]

A smooth uniform sphere  $A$  has mass  $0.2\text{ kg}$  and another smooth uniform sphere  $B$ , with the same radius as  $A$ , has mass  $0.4\text{ kg}$ .

The spheres are moving on a smooth horizontal surface when they collide obliquely. Immediately before the collision, the velocity of  $A$  is  $(3\mathbf{i} + 2\mathbf{j})\text{ m s}^{-1}$  and the velocity of  $B$  is  $(-4\mathbf{i} - \mathbf{j})\text{ m s}^{-1}$

At the instant of collision, the line joining the centres of the spheres is parallel to  $\mathbf{i}$

The coefficient of restitution between the spheres is  $\frac{3}{7}$

(a) Find the velocity of  $A$  immediately after the collision.

(7)

(b) Find the magnitude of the impulse received by  $A$  in the collision.

(2)

(c) Find, to the nearest degree, the size of the angle through which the direction of motion of  $A$  is deflected as a result of the collision.

(3)

(Total for question = 12 marks)

(Q06 9FM0/03C, June 2019)

**Q9.**

Unless otherwise indicated, whenever a numerical value of  $g$  is required, take  $g = 9.8\text{ ms}^{-2}$  and give your answer to either 2 significant figures or 3 significant figures.

[In this question  $\mathbf{i}$  and  $\mathbf{j}$  are perpendicular unit vectors in a horizontal plane.]

A smooth uniform sphere  $A$  has mass  $2m\text{ kg}$  and another smooth uniform sphere  $B$ , with the same radius as  $A$ , has mass  $3m\text{ kg}$ .

The spheres are moving on a smooth horizontal plane when they collide obliquely.

Immediately before the collision the velocity of  $A$  is  $(3\mathbf{i} + 3\mathbf{j})\text{ m s}^{-1}$  and the velocity of  $B$  is  $(-5\mathbf{i} + 2\mathbf{j})\text{ m s}^{-1}$ .

At the instant of collision, the line joining the centres of the spheres is parallel to  $\mathbf{i}$ .

The coefficient of restitution between the spheres is  $\frac{1}{4}$ .

(a) Find the velocity of  $B$  immediately after the collision.

(7)

(b) Find, to the nearest degree, the size of the angle through which the direction of motion of  $B$  is deflected as a result of the collision.

(2)

(Total for question = 9 marks)

(Q06 9FM0/3C-4C, Specimen papers)