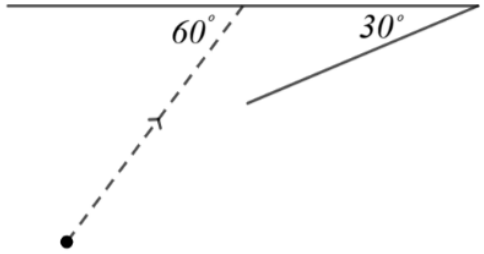
Chapter 5 Mechanics – Oblique Impacts - FM1 Test – www.m4ths.com – Steve Blades

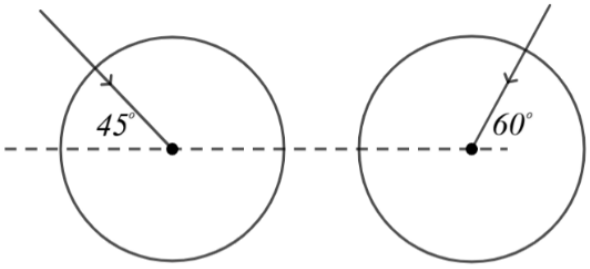
(1) A smooth sphere is dropped from a height of 1 metre onto a smooth inclined plane which is inclined at an angle α to the horizontal where $\tan\alpha = 2$. The coefficient of restitution between the sphere and the plane is $\frac{1}{\sqrt{2}}$.
After striking the plane the sphere rebounds with a speed $v\ ms^{-1}$. Show that $v^2 = \frac{9g}{5}$.

(2) A smooth sphere travels with speed $6ms^{-1}$ along a smooth horizontal table and collides with a smooth wall. The direction of motion of the sphere makes an angle of 60^o with the first wall. The sphere bounces off the wall and collides with a second wall which makes an angle of 30^o with the first wall as shown below.



Given that the coefficient of restitution between the sphere and both walls is 0.8, find the speed of the sphere after it rebounds from the second wall giving your answer to 3SF.

(3) Sphere A of mass $1kg$ has speed $6ms^{-1}$ and collides obliquely with Sphere B of mass $2kg$ and speed $2ms^{-1}$ on a smooth horizontal surface. A is moving in a direction at 45^o and B moving in a direction at 60^o to the line of centres of the two spheres as shown below.



After the two spheres collide sphere A continues to move perpendicular to the line of centres of the two spheres. Show that the coefficient of restitution between the two spheres can be written in the form $e = \frac{p+r\sqrt{q}}{s}$

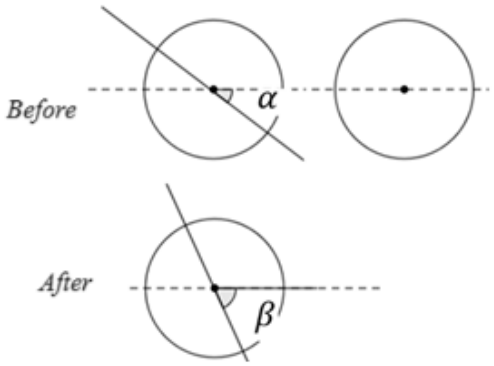
(4) A smooth sphere of mass $4kg$ has velocity $(2\mathbf{i} + 4\mathbf{j})ms^{-1}$ and moves on a smooth horizontal plane. There sphere strikes a wall that is parallel to the vector $\mathbf{j}$. Given that the coefficient of restitution between the wall and sphere is $\frac{1}{2}$, find the kinetic energy lost by the sphere in the collision.

(5) Sphere A of mass $1kg$ and Sphere B of mass $2kg$ collide on a smooth horizontal surface. Sphere A has velocity $(6\mathbf{i}-\mathbf{j})ms^{-1}$and Sphere B has velocity $(-4\mathbf{i}+\mathbf{j})ms^{-1}$ before they collide. When the spheres collide, their line of centres is parallel to the vector $\mathbf{i}$. The velocity of A after the collision is $(p\mathbf{i}+q\mathbf{j})ms^{-1}$ and the velocity of B is $(r\mathbf{j})ms^{-1}$. Find the coefficient of restitution between the two spheres.

(6) A smooth sphere strikes a smooth vertical whilst travelling on a smooth horizontal plane surface. The velocity of the sphere makes angle of α with the wall where $\tan\alpha=\frac{3}{4}$ and rebounds from the wall where the velocity of the sphere makes an angle of β where $\tan\beta=\frac{5}{12}$.
(a) Find the value of e, the coefficient of restitution between the wall and the sphere.
(b) Show that the angle of deflection of the sphere θ is such that $\tan\theta=\frac{56}{33}$

(7) A smooth sphere of mass $2kg$ has velocity $(3\mathbf{i}-2\mathbf{j})ms^{-1}$ and collides with a smooth vertical wall. The velocity of the sphere after it rebounds from the wall is $(-\mathbf{i}+\mathbf{j})ms^{-1}$.
Show that the coefficient of restitution between the sphere and the wall is $\frac{7}{18}$

(8) Two identical smooth spheres A and B collide obliquely. Before the collision Sphere B is stationery and Sphere A moves with a velocity that makes an angle of α with the line of centres of the spheres. After the spheres collide the velocity of A makes an angle β with the line of centres of the spheres as shown below with A on the left and B on the right.



Given that $\tan\alpha=0.75$ and the coeffieient of resituion between the spheres is 0.5, show that the angle γ sphere A deflects through satisfies the equation $\tan\gamma=\frac{9}{13}$.

(9) Two identical spheres A and B collide. The velocity of A prior to the collision is $(4\mathbf{i}+\mathbf{j})ms^{-1}$and the velocity of B prior to the collision is $(-\mathbf{i}-2\mathbf{j})ms^{-1}$. After the collision A has velocity $(3\mathbf{i}-\mathbf{j})ms^{-1}$.
(a) Show that sphere B is brought to rest in the collision.
(b) Find the coefficient of restitution between the two spheres.

(10) A sphere has velocity $(6\mathbf{i}-8\mathbf{j})ms^{-1}$ and collides with a smooth wall parallel to the vector $\mathbf{i}$. After the sphere rebounds it then hits a second wall which is perpendicular to the first wall. After the second collision the velocity of the sphere is $(k\mathbf{i}+4\mathbf{j})ms^{-1}$ where k is a constant. Given that the coefficient of restitution between the sphere and the two walls is the same, find the value of k.