Linear momentum

Friday, 29 January, 2021 21:37

A $3\,kg$ particle has a velocity of $(3\hat{\imath} - 4\hat{\jmath})\ m/s$.

- Find its x and y components of momentum.
- Find the magnitude and direction of its momentum.

Momentum and kinetic energy

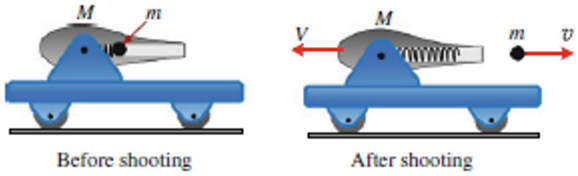
Saturday, 30 January, 2021 15:24

An object has a kinetic energy of $275\,J$ and a momentum of magnitude $25\,kg.m/s$. Find the speed and mass of the object.

Conservation of momentum

Saturday, 30 January, 2021 15:25

A cannon of mass $M = 1500\,kg$ shoots a projectile of mass $m = 100\,kg$ with a horizontal speed $v = 30\ m/s$, as shown. If the cannon can recoil freely on a horizontal ground, what is its recoil speed V just after shooting the projectile?



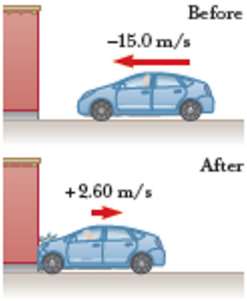
Before shooting After shooting

1-D impulse

Saturday, 30 January, 2021 15:25

In a particular crash test, a car of mass $1500\,kg$ collides with a wall. The initial and final velocities of the car are $\vec{v}_i = -15\,\hat{\imath}\ m/s$ and $\vec{v}_f = 26\,\hat{\imath}\ m/s$, respectively. If the collision lasts $0.15\,s$, find:

- the impulse caused by the collision and
- the average net force exerted on the car.

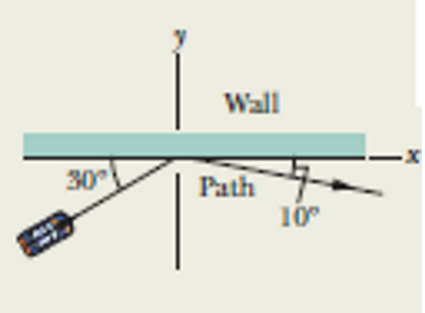


2-D impulse

Saturday, 30 January, 2021 15:26

A race car collides with the racetrack wall. Just before the collision, it is traveling at speed $v_i = 70\ m/s$ along a straight line at 30° from the wall. Just after the collision, it is traveling at speed $v_f = 50\ m/s$ along a straight line at 10° from the wall. The driver's mass is $80\,kg$.

- What is the impulse on the driver due to the collision?
- The collision lasts for $14\,ms$. What is the magnitude of the average force on the driver during the collision?



Impulse - Area

Saturday, 30 January, 2021 15:26

The magnitude of the net force exerted in the x direction on a $2.5\ kg$ particle varies in time as shown. Find:

- the impulse of the force over the $5\ s$ time interval, (b) the final velocity the particle attains if it is originally at rest,
- its final velocity if its original velocity is $-2\ \hat{\imath}\ m/s$, and
- the average force exerted on the particle for the time interval between 0 and $5\ s$.

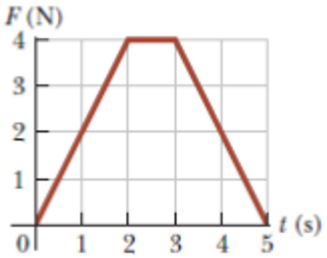


Figure P9.19

Impulse - Integration

Saturday, 30 January, 2021 15:27

Starting from rest, a $65\,kg$ athlete jumps down onto a platform from a height of $0.6\,m$. While she is in contact with the platform during the time interval $0 < t < 0.8\,s$, the force she exerts on it is described by the function: $F(t) = 9200t - 11500t^2$, where F is in Newtons and t is in seconds.

- What impulse did the athlete receive from the platform?
- With what speed did she reach the platform?
- With what speed did she leave it?
- To what height did she jump upon leaving the platform?

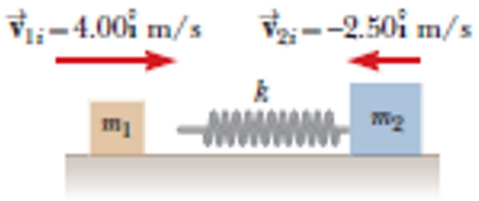
1-D elastic collision

Saturday, 30 January, 2021 15:27

A block of mass $m_1 = 1.6\,kg$ initially moving to the right with a speed of $4\ m/s$ on a frictionless, horizontal track collides with a light spring attached to a second block of mass $m_2 = 2.1\,kg$ initially moving to the left with a speed of $2.5\ m/s$. The spring constant is $600\ N/m$.

- Find the velocities of the two blocks after the collision.
- Determine the velocity of block 2 during the collision, at the instant block 1 is moving to the right with a velocity of $3\ m/s$.
- Determine the distance the spring is compressed at that instant.

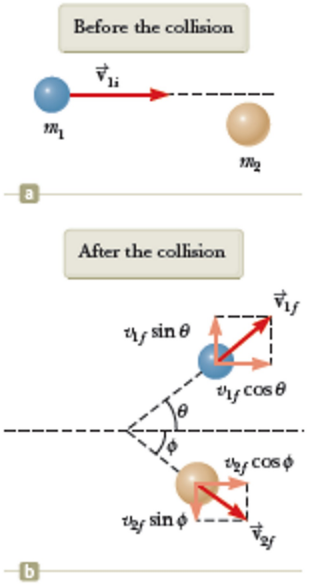
(NOTE: Because the spring force is conservative, kinetic energy in the system of two blocks and the spring is not transformed to internal energy during the compression of the spring. We can categorize the collision as being elastic.)



2-D elastic collision

Saturday, 30 January, 2021 15:27

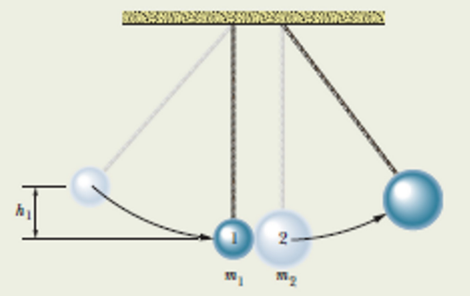
A proton collides elastically with another proton that is initially at rest. The incoming proton has an initial peed of $3.5 \times 10^5\ m/s$ and makes a glancing collision with the second proton as shown. After the collision, one proton moves off at an angle of 37° to the original direction of motion and the second deflects at an angle of φ to the same axis. Find the final speeds of the two protons and the angle φ.



Two pendulums

Saturday, 30 January, 2021 15:28

Two metal spheres, suspended by vertical cords, initially just touch, as shown. Sphere 1, with mass $m_1 = 30\ g$ is pulled to the left to height $h_1 = 8\ cm$ and then released from rest. After swinging down, it undergoes an elastic collision with sphere 2, whose mass $m_2 = 75\ g$. What is the velocity v_{1f} of sphere 1 just after the collision?



1-D perfectly inelastic collision

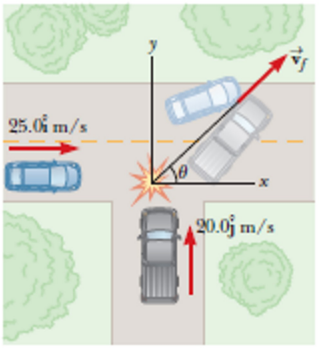
Saturday, 30 January, 2021 15:28

An $1800\,kg$ car stopped at a traffic light is struck from the rear by a $900\,kg$ car. The two cars become entangled, moving along the same path as that of the originally moving car. If the smaller car were moving at $20\ m/s$ before the collision, what is the velocity of the entangled cars after the collision?

2-D perfectly inelastic collision

Saturday, 30 January, 2021 15:29

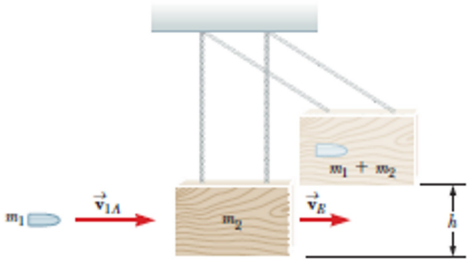
A $1500\,kg$ car traveling east with a speed of $25\ m/s$ collides at an intersection with a $2500\,kg$ truck traveling north at a speed of $20\ m/s$, as shown. Find the direction and magnitude of the velocity of the wreckage after the collision, assuming the vehicles stick together after the collision.



The Ballistic Pendulum

Saturday, 30 January, 2021 15:28

A projectile of mass m_1 is fired into a large block of wood of mass m_2 suspended from some light wires. The projectile embeds in the block, and the entire system swings through a height h. How can we determine the speed of the projectile from a measurement of h?



1-D inelastic collision

Saturday, 30 January, 2021 15:30

A $1200\,kg$ car traveling initially at $v_{Ci} = 25\ m/s$ in an easterly direction crashes into the back of a $9000\,kg$ truck moving in the same direction at $v_{Ti} = 20\ m/s$. The velocity of the car immediately after the collision is $v_{Cf} = 18\ m/s$ to the east.

- What is the velocity of the truck immediately after the collision?
- What is the change in mechanical energy of the car–truck system in the collision?
- Account for this change in mechanical energy.

2-D inelastic collision

Saturday, 30 January, 2021 15:30

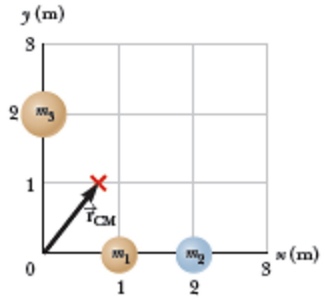
A $0.3\,kg$ puck, initially at rest on a horizontal, frictionless surface, is struck by a $0.2\,kg$ puck moving initially along the x axis with a speed of $2\ m/s$. After the collision, the $0.2\,kg$ puck has a speed of $1\ m/s$ at an angle of $\theta = 53^{\circ}$ to the positive x axis.

- Determine the velocity of the $0.3\,kg$ puck after the collision.
- Find the fraction of kinetic energy transferred away or transformed to other forms of energy in the collision.

The com of Three Particles

Saturday, 30 January, 2021 15:30

A system consists of three particles located as shown. Find the center of mass of the system. The masses of the particles are $m_1 = m_2 = 1\ kg$ and $m_3 = 2\ kg$.



The Exploding Rocket

Saturday, 30 January, 2021 15:31

A rocket is fired vertically upward. At the instant it reaches an altitude of $1000\,m$ and a speed of $v_i = 300\ m/s$ it explodes into three fragments having equal mass. One fragment moves upward with a speed of $v_1 = 450\ m/s$ following the explosion. The second fragment has a speed of $v_2 = 240\ m/s$ and is moving east right after the explosion. What is the velocity of the third fragment immediately after the explosion?

Acceleration of com of three particles

Saturday, 30 January, 2021 15:32

Three particles are initially at rest. Each experiences an *external* force due to bodies outside the three-particle system. The three forces are: $\vec{F}_1 = 6\,N, 45^\circ$, $\vec{F}_2 = 12\,N, 180^\circ$ and $\vec{F}_3 = 14\,N, 0^\circ$.What is the acceleration of the center of mass of the system, and in what direction does it move?

Motion of com

Saturday, 30 January, 2021 15:32

The vector position of a $3.5\ g$ particle moving in the xy plane varies in time according to $\vec{r}_1 = (3\hat{\imath} + 3\hat{\jmath})\ t + \ (2\hat{\jmath})\ t^2$, where t is in seconds and $\vec{r}$ is in centimeters. At the same time, the vector position of a $5.5\ g$ particle varies as $\vec{r}_2 = 3\hat{\imath} - (2\hat{\imath})\ t^2\ -\ (6\hat{\jmath})t$. At $t = 2.5\ s$ determine:

- the vector position of the center of mass,
- the linear momentum of the system,
- the velocity of the center of mass,
- the acceleration of the center of mass, and
- the net force exerted on the two-particle system.