Applications

Alexis Tatore

Professional Application - #8

A car moving at 10 m/s crashes into a tree and stops in 0.26 s. Calculate the force the seat belt exerts on a passenger in the car to bring him to a halt. The mass of the passenger is 70 kg.

Professional Application - #8

F_{avg} = (mass * (final velocity - initial velocity)) / time

F_{avg} = (70 kg * (10 m/s)) / 0.26 s

F_{avg} = (700 kgm/s)/(0.26 s)

F_{avg} = 2692.31 N

Professional Application - #25

Considering problem #8…

Would the answer to this question be different if the car with the 70-kg passenger had collided with a car that has a mass equal to and is traveling in the opposite direction and at the same speed? Explain your answer.

Professional Application - #25

Momentum: When two identical cars collide, momentum is conserved. Final velocity = 0 for both cars.

Force: Undetermined since time is unknown… but would have more force in this example.


BRIGGS
WBC
GRANT
WBC
GRANT

Professional Application - #10

A professional boxer hits his opponent with a 1000-N horizontal blow that lasts for 0.150 s.

(a) Calculate the impulse imparted by this blow.
(b) What is the opponent’s final velocity, if his mass is 105 kg and he is motionless in midair when struck near his center of mass?

Professional Application - #10

(a) Impulse = F * T → Impulse = 1000N * 0.150 s → Impulse = 150 N

(b) Force * time = change in momentum

1000 * 0.150 s = (105)(x)-(105)(0)

150 = 105x x = 1.43 m/s

'Urgent need'
to remove space debris

Professional Application - #12

One hazard of space travel is debris left by previous missions. There are several thousand objects orbiting Earth that are large enough to be detected by radar, but there are far greater numbers of very small objects, such as flakes of paint. Calculate the force exerted by a 0.100-mg chip of paint that strikes a spacecraft window at a relative speed of 4.00*10^3 m/s, given the collision lasts 6.00*10^-8 s.

Professional Application - #12

Force * time = mass * change in velocity

Force * 0.00000006 s = 0.0001 kg * 4000 m/s

Force * 0.00000006 s = 0.0001 kg * 4000 m/s

Force = FIX THIS

Professional Application - #29

Two manned satellites approach one another at a relative speed of 0.250 m/s, intending to dock. The first has a mass of 4.00*10*3 and the second a mass of 7.50*10^3 kg. If the two satellites collide elastically rather than dock, what is their final relative velocity?

Professional Application - #29

Momentum is conserved in elastic collisions…

So, 0.250 m/s

Professional Application - #38

(e) Calculate the momentum of a 110-kg football player running at 8.00 m/s. Compare the player’s momentum with the momentum of a hard-thrown 0.410-kg football that has a speed of 25.0 m/s.

Professional Application - #38

(a) $P=MV$

$P=(110\ kg)(8.00\ m/s)=880\ kg\cdot m/s$

(b) $P=MV$

$P=(0.410\ kg)(25.0\ m/s)=10.3\ kg\cdot m/s$

Professional Application - #36

A 30,000-kg freight car is coasting at 0.50 m/s with negligible friction under a hopper that dumps 110,000 kg of scrap metal into it.

(a) What is the final velocity of the loaded freight car?
(b) How much kinetic energy is lost?

Professional Application - #36

(a) final velocity = initial momentum / (mass + mass of scrap metal)

15000/(30000+110000) = 0.107

(b) How much kinetic energy is lost?

initial kinetic energy - final kinetic energy

171.73 - 801.43 = -629.7 J… 629.7 J lost

Professional Application - #49

Ernest Rutherford demonstrated that nuclei were very small and dense by scattering helium-4 nuclei from gold-197 nuclei. The energy of the incoming helium nucleus was 8.00*10^-13 J, and the masses of the helium and gold were 6.68*10^-27 kg and 3.29*10^-25 kg, respectively.

(a) If a helium nucleus scatters to an angle of 120 degrees during an elastic collision with a gold nucleus, calculate the helium nucleus' final speed and the final velocity of the gold nucleus.

(b) What is the final kinetic energy of the helium nucleus?

Professional Application - #49

(a) 8.00*10^-13 J = (6.68*10^-27 kg) * change in velocity
v = 1.198 m/s

8.00*10^-13 J = (3.29*10^-25 kg) * change in velocity

v = 2.432

(b) KE = ½(6.68*10^-27 kg)(1.198 m/s^2)

KE = 4.794*10^-27 J