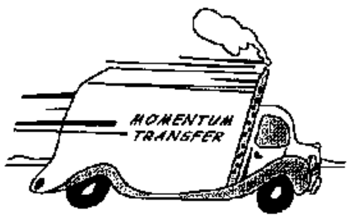


"CRASH COURSE" ACTIVITY

"Understanding Car Crashes It's Basics Physics"

Video Discussion Questions

Teacher Post-Video Answers

Directions:

After viewing the video, answer the following questions in the space provided. Be prepared to discuss your responses with your classmates while in small groups or as an entire class.

Post-Video "Crash" Questions

1. Ever tried to stop a 150 pound (68 kg) cannonball fired towards you at 30 mph (48 km/hr.)? No, probably not. But you may have tried to brace yourself in a car collision. How are the two situations similar?

   Both you and the cannonball have momentum based upon mass and velocity. If you are traveling 30 mph and weigh 150 pounds your momentum would equal the cannonball's. In a major collision, it is impossible to prevent injuries by bracing yourself. No matter how strong you think you are, you are not strong enough to stop your inertia during a collision.

2. Show mathematically why an 80,000 pound (36,000 kg) big rig traveling 2 mph (0.89 m/s) has the SAME MOMENTUM as a 4,000 pound (1,800 kg) sport utility vehicle traveling 40 mph (18 m/s).

   Momentum is the product of an object's mass and velocity. The formula is $p = mv$. The product of each is equivalent.

   The SI unit for momentum is the kilogram x meter/second (kg x m/s).

   Truck momentum = (36,000 kg)(0.89 m/s) = 32,000 kg x m/s

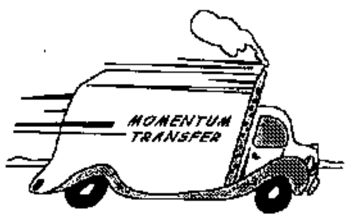
   SUV momentum= (1,800 kg)(18 m/s) = 32,000 kg x m/s

3. During the Egg-Throwing Demonstration, which egg experienced the greater impulse, the egg that hit the wall or the bed sheet? (Be careful here!) Which egg experienced the greater force of impact? Which egg experienced the greater time of impact?

   If their momenta are equal before the collisions (same mass and velocity), both eggs experience identical impulses because both are stopped by the collision.

   The egg that hit the crash barrier experienced the greater impact force due to the shorter impact time.

   The egg that collided with the bed sheet experienced the greater time of impact, thereby experiencing a smaller stopping force over a longer time interval.



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4. Explain how the fortunate race car drivers survived their high speed accidents.

   The impulse that the wall applied to both cars was identical BUT remember impulse is the force of impact multiplied by the time of impact. With the fortunate driver, the identical impulse was a product of a small force extended over a long period of time.

5. Describe other examples where momentum is reduced by applying a smaller collision force over a longer impact time (or where things "give way" during a collision to lessen the impact force)?

   Answers will vary. Some examples: Bungee jumping; trampolines; trapeze safety nets; falling on grass compared to concrete; many football players prefer the "give" of natural grass to the harder artificial turf.

6. Which would be more damaging to your car: having a head-on collision with an identical car traveling at an identical speed or driving head on into the Vehicle Research Center's 320,000 pound (145,455 kg) deformable crash barrier? Explain.

   Both crashes produce the same result. Either way the car rapidly decelerates to a stop. In a head-on crash of identical cars traveling at equal speeds, the result is equal impact forces and impact times (according to Newton's Third Law of Motion), and therefore equal changes in momenta. Using a crash barrier is more cost efficient.

7. Show mathematically why a small increase in your vehicle's speed results in a tremendous increase in your vehicle's kinetic energy. (For example: doubling your speed from 30 mph to 60 mph results in a quadrupling of your kinetic energy.)

   The velocity is squared in the equation; therefore if the speed is first doubled then squared, its kinetic energy must quadruple to keep the equation balanced.

   $KE = 1/2\ mv^2 \qquad 4KE = 1/2\ m2v^2$

8. The Law of Conservation of Energy states: energy cannot be created or destroyed; it can be transformed from one form to another but the total amount of energy never changes. Car crashes can involve huge amounts of energy. How does the crashworthiness of the car affect the transfer and transformations of the energy and, ultimately, protect the occupants?

   In a crash of a well designed car, the kinetic energy does the work that crushes the car's crumple zones. Some of the energy also becomes heat and sound generated by the crash. The safety cage must be strong enough to resist the forces that arise during the crash so that it holds its shape and allows the restraint system to do its job.