

AP Physics C  
HW Set 1  
**Average Velocity & Acceleration**

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1. During a hard sneeze, your eyes might shut for 0.49 [s]. If you are driving a car at 55 [mph] (24.58 [m/s]) during such a sneeze, how far does the car move during that time?
  
2. In 2009, Usain Bolt set the world record for the 100 m dash in a time 9.58 [s]\*.
  - a. What was his average velocity for the entire race?
  - b. Usain ran the first 40 meters of the race in 4.64 [s]. What was his average velocity for the first 40 [m]?
  - c. Usain accelerated out of the blocks from rest to a speed of 6.1 [m/s] in the first second of his race. What was his acceleration rate during this time interval?
  
3. A plane lands on a runway with a speed of 120 [m/s], moving east, and it slows to a stop in 11 [s]. What is the magnitude and direction of the plane's average acceleration during this time interval?
  
4. Influenced by the gravitational pull of a distant star, the velocity of an asteroid changes from +20.5 [km/s] to -19 [km/s] over a period of 2.12 years.
  - a. What is the total change in the asteroid's velocity?
  - b. What is the asteroid's average acceleration during this interval?
  
5. A proton (a.k.a large hadron) in the linear accelerator (LINAC) at CERN is accelerated from rest to  $0.314c$  (use  $c = 3.0 \times 10^8$  [m/s]). What is the average acceleration of the hadron if this it reaches this speed in 0.025 [s].
  
6. In a Gauntlet Task 1 trial, your cart is traveling away from the motion sensor at 6.56 [m/s]. When the cart is exactly 1 [m] from the sensor, the sensor's ultrasonic wave hits the cart and begins its trip back to the sensor.

In the time needed for the ultrasonic wave to travel back to the sensor to register a position value, how far from the original 1 [m] location has the cart moved? The speed of an ultrasonic wave is 343.2 [m/s]. That this calculation can give you an idea of the amount of error there is in a measurement using an ultrasonic motion sensor.

## HW Set 1 Answers

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- 1. 12.03 [m]
- 2a. 10.43 [m/s]
- 2b. 8.62 [m/s]
- 2c. 6.1 [m/s<sup>2</sup>]
- 3. 10.9 [m/s<sup>2</sup>]
- 4a. -39500 [m/s]
- 4b. 0.000591 [m/s<sup>2</sup>]
- 5. 3.77 x 10<sup>9</sup> [m/s<sup>2</sup>]
- 6. 0.0190 [m]

\* <http://io9.gizmodo.com/the-physics-of-usain-bolts-world-record-100-meter-dash-924744818>