Concepts of Physics: Homework 3 Solution

Due: 14 September 2022

1 Space cannon

A spacecraft, that is very distant from any other objects, fires a cannonball, which leaves the spacecraft with speed 200mph. Which of the following is true (choose one) after the cannonball leaves the spacecraft? Explain your answer.

i) The cannonball travels with a constant speed of 200mph.

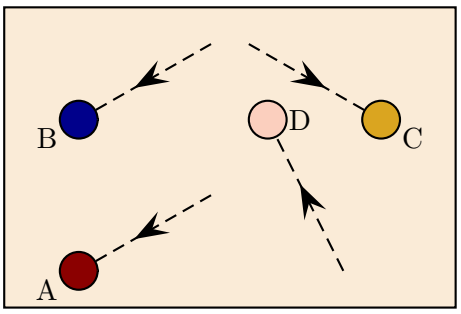
ii) The cannonball loses speed rapidly and eventually travels with a smaller constant non-zero speed.

iii) The cannonball loses speed gradually and eventually travels with a smaller constant non-zero speed.

iv) The cannonball loses speed constantly and eventually comes to a stop.

2 Pool balls

Several pools balls collide. At some stage after the collision the balls move on the pool table along the illustrated paths. Ball A moves with speed 12.0 m/s, ball B moves with speed 12.0 m/s, ball C moves with speed 12.0 m/s, and ball D moves with speed 15.0 m/s.

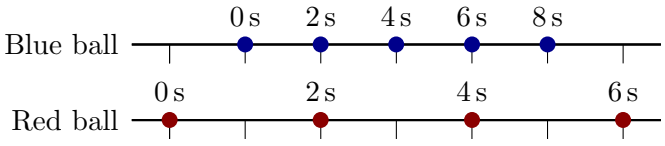


a) List all pairs of balls that have the same velocity as each other. Explain your answer.

b) List all pairs of balls that have the different velocities to each other. Explain your answer.

3 Racing balls

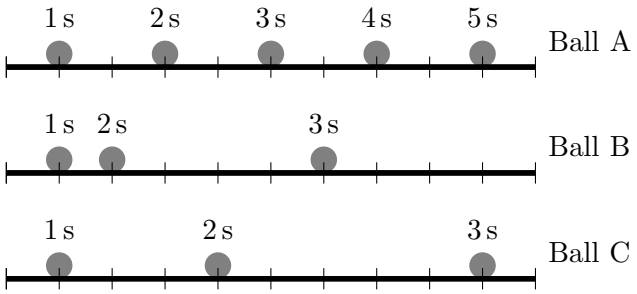
Two balls race each other. The locations of each ball are photographed at instants 2 s apart.



a) Which ball has the larger speed? Explain your answer.
b) Which ball has the larger acceleration? Explain your answer.
c) Suppose that the marks are 30 cm apart. Determine the speed of each ball.

4 Velocity and acceleration

Three balls move as illustrated. The positions of the balls are recorded at intervals spaced 1 s apart.



a) Which of the balls travel with constant speed and which travel with changing speed? Explain your answer.
b) Consider the average speed of each ball in the interval from 2 s to 3 s. Rank the balls in order of average speed (from smallest to largest) during this interval.
c) Which of the balls travel with acceleration exactly equal to zero? Explain your answer.
d) Use the motions of these balls to decide whether the following statement is true: "If one object travels with a greater acceleration than a second object, then the speed of the first object is always larger than the speed of the second object." Is this statement correct or not? Explain it based on the motions of the illustrated balls and your answers the the previous parts of this question.

5 Bicycle vs. aircraft

Suppose that an aircraft passing overhead maintains a constant speed of 400 mph. During the time that it passes above you, you pedal your bicycle from rest to a speed of 10 mph. Do you or the aircraft have a greater acceleration? Explain your answer.

6 Predicting velocity using acceleration

A blue ball and a red ball both travel to the right. At an initial instant the red ball has speed 20 m/s and the blue ball has speed 12 m/s. The acceleration of the red ball is 2.0 m/s^2 and that of the blue ball is 4.0 m/s^2.

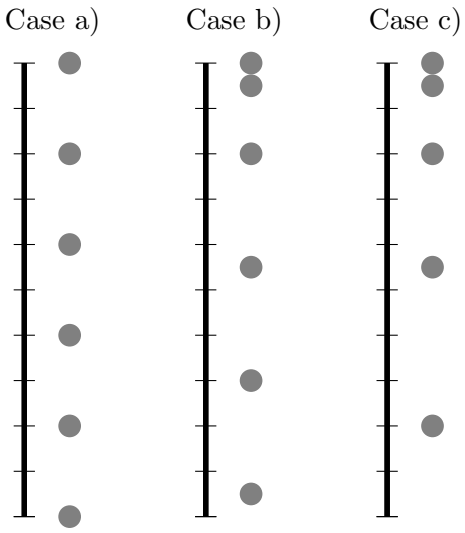
a) Determine the velocity of each ball 2.0 s after the initial instant.
b) Determine the velocity of each ball 3.0 s after the initial instant.
c) Both balls are observed at the same instant later. Will the red ball definitely be moving faster than the blue ball at this later instant? Explain your answer.

7 Bouncing ball

A ball is thrown against a wall with a speed of 20 m/s and bounces back with a speed of 20 m/s. Is the acceleration of the ball zero or non-zero from the moment just before it hits the wall until the moment just after it hits the wall? Justify your answer.

8 Freely falling balls

A ball is allowed to fall and photographs of its position are taken every 0.10 s. Which of the following represents the correct sequence of positions? Ignore air resistance and explain your choice.



9 Reading exercise: Newtonian and Aristotelian dynamics

Read sections 4.1 and 4.2 on pages 72-76. This series of exercises offers examples and exercises that you could construct to check that you understand the content of the text correctly.

a) According to Newton's theory of motion do forces cause non-zero velocities or do they cause accelerations?

b) An aircraft flies horizontally at constant speed in a straight line. What does Newton's theory predict that the total force exerted on the aircraft must be? During this time its engines **are** running and they **do** exert forces on the aircraft. How does Newton's theory explain the fact that the aircraft does not accelerate and yet the engines exert forces on the aircraft?

c) Try Concept Check 1. Check your answer against that in the back of the text.