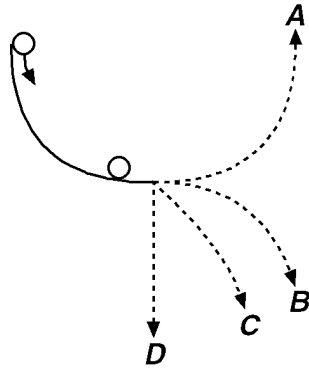


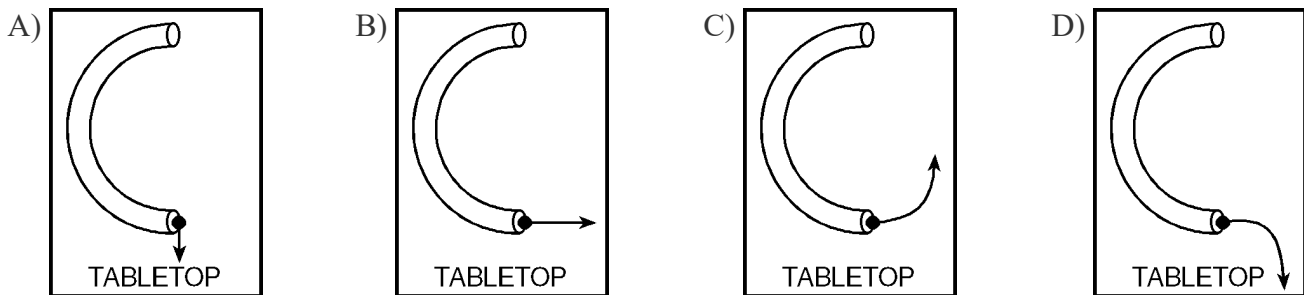
1) A ball rolls down a curved ramp as shown in the diagram below.



Which dotted line *best* represents the path of the ball after leaving the ramp?

- A) A B) B C) C D) D

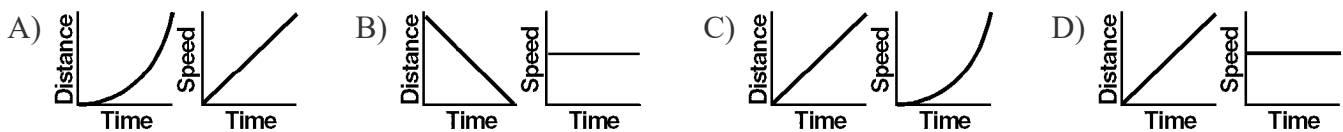
2) A ball rolls through a hollow semicircular tube lying flat on a horizontal tabletop. Which diagram *best* shows the path of the ball after emerging from the tube, as viewed from above?



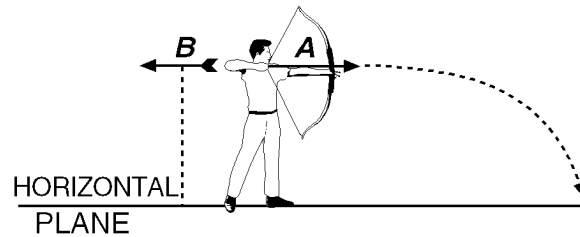
3) The diagram below represents a bicycle and rider traveling to the right at a constant speed. A ball is dropped from the hand of the cyclist.



Which set of graphs *best* represents the horizontal motion of the ball relative to the ground? [Neglect air resistance.]

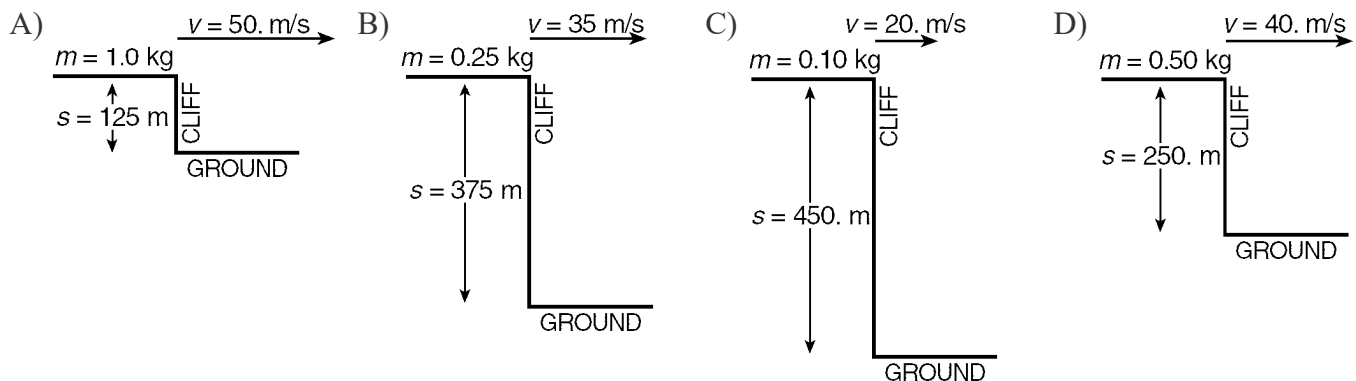


- 4) Above a flat horizontal plane, an arrow, A , is shot horizontally from a bow at a speed of 50 meters per second, as shown in the diagram below. A second arrow, B , is dropped from the same height and at the same instant as A is fired.



Neglecting air friction, compared to the amount of time A takes to strike the plane, the amount of time B takes to strike the plane is

- A) greater
 B) less
 C) the same
- 5) Four different balls are thrown horizontally off the top of four cliffs. In which diagram does the ball have the *shortest* time of flight?



- 6) A 1-kilogram object is thrown horizontally and a 2-kilogram object is dropped vertically at the same instant and from the same point above the ground. If friction is neglected, at any given instant *both* objects will have the same
- A) momentum
 B) height
 C) total velocity
 D) kinetic energy

Questions 7 through 9 refer to the following:

An object is thrown horizontally off a cliff with an initial velocity of 5.0 meters per second. The object strikes the ground 3.0 seconds later.

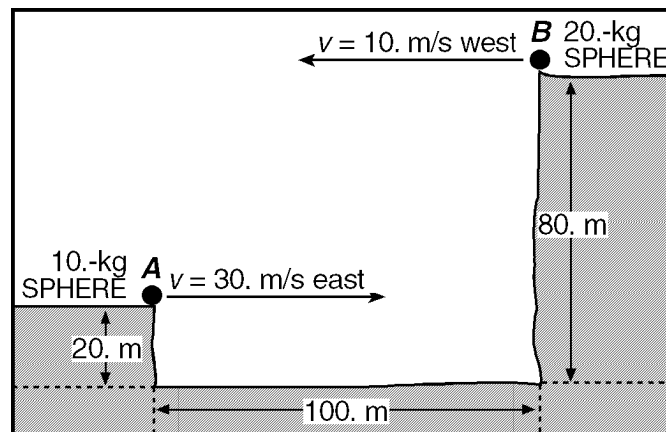
- 7) What is the vertical speed of the object as it reaches the ground? [*Neglect friction.*]
- A) 5.0 m/s
 B) 15 m/s
 C) 130 m/s
 D) 29 m/s
- 8) What is the horizontal speed of the object 1.0 second after it is released? [*Neglect friction.*]
- A) 5.0 m/s
 B) 10. m/s
 C) 15 m/s
 D) 30. m/s

9) How far from the base of the cliff will the object strike the ground? [*Neglect friction.*]

- A) 2.9 m B) 9.8 m C) 15 m D) 44 m

Questions 10 through 12 refer to the following:

In the diagram below, a 10.-kilogram sphere, *A*, is projected horizontally with a velocity of 30. meters per second due east from a height of 20. meters above level ground. At the same instant, a 20.-kilogram sphere, *B*, is projected horizontally with a velocity of 10. meters per second due west from a height of 80. meters above level ground. [*Neglect air friction.*]



- 10) Initially, the spheres are separated by a horizontal distance of 100. meters. What is the horizontal separation of the spheres at the end of 1.5 seconds?
- A) 30. m B) 45 m C) 40. m D) 15 m
- 11) The magnitude of the horizontal acceleration of sphere *A* is
- A) 0.0 m/s^2 B) 9.8 m/s^2 C) 15 m/s^2 D) 2.0 m/s^2
- 12) Compared to the vertical acceleration of sphere *A*, the vertical acceleration of sphere *B* is
- A) twice as great B) one-half as great C) four times as great D) the same