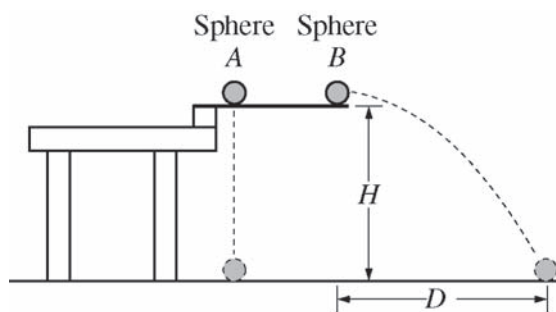


2015 AP[®] PHYSICS 1 FREE-RESPONSE QUESTIONS



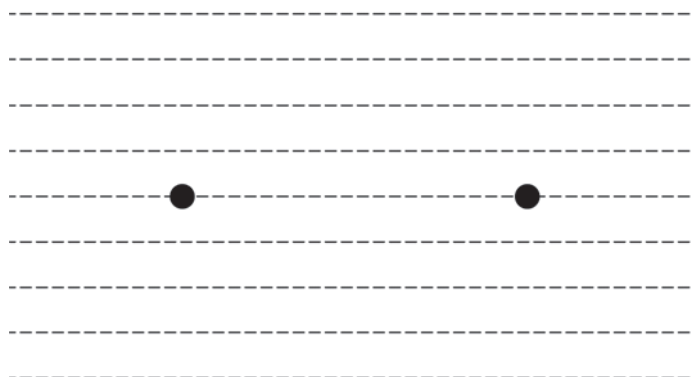
4. (7 points, suggested time 13 minutes)

Two identical spheres are released from a device at time $t = 0$ from the same height H , as shown above. Sphere A has no initial velocity and falls straight down. Sphere B is given an initial horizontal velocity of magnitude v_0 and travels a horizontal distance D before it reaches the ground. The spheres reach the ground at the same time t_f , even though sphere B has more distance to cover before landing. Air resistance is negligible.

- (a) The dots below represent spheres A and B . Draw a free-body diagram showing and labeling the forces (not components) exerted on each sphere at time $\frac{t_f}{2}$.

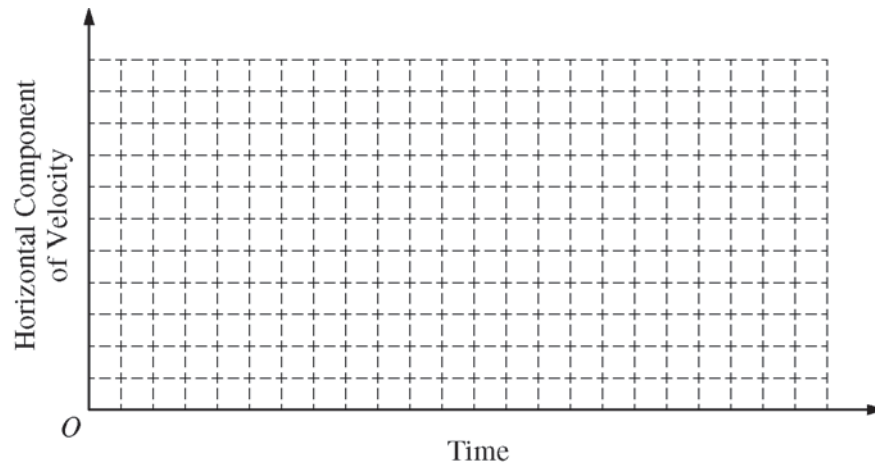
Sphere A

Sphere B



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- (b) On the axes below, sketch and label a graph of the horizontal component of the velocity of sphere *A* and of sphere *B* as a function of time.



- (c) In a clear, coherent, paragraph-length response, explain why the spheres reach the ground at the same time even though they travel different distances. Include references to your answers to parts (a) and (b).

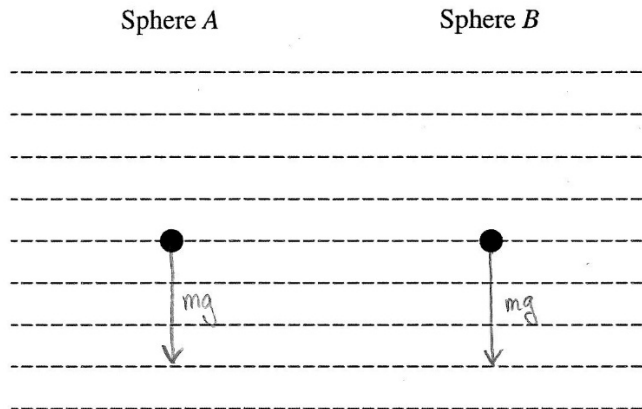
AP[®] PHYSICS 1 2015 SCORING GUIDELINES

Question 4

7 points total

**Distribution
of points**

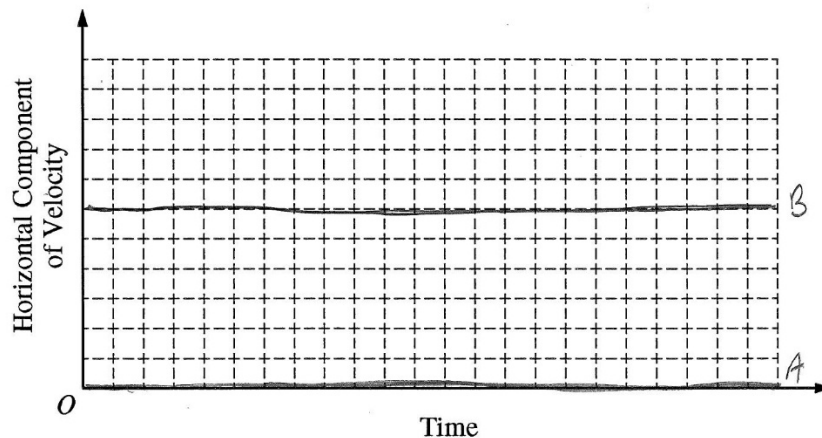
(a) 1 point



For sketching only one force pointing straight down from each sphere and indicating that this force represents the force of gravity

1 point

(b) 1 point



For sketching a horizontal line at zero velocity for sphere A, and sketching a horizontal line at some non-zero velocity for sphere B

1 point

(c) 5 points

For indicating that the difference in horizontal motion does not affect the vertical motion of the spheres

1 point

For indicating that both spheres start with the same vertical velocity

1 point

For indicating that both spheres have the same vertical acceleration

1 point

For indicating that falling the same height would take the same time

1 point

For no incorrect or irrelevant statements

1 point