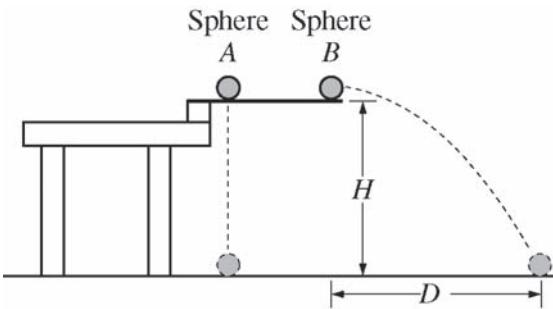


2015 AP® PHYSICS 1 FREE-RESPONSE QUESTIONS



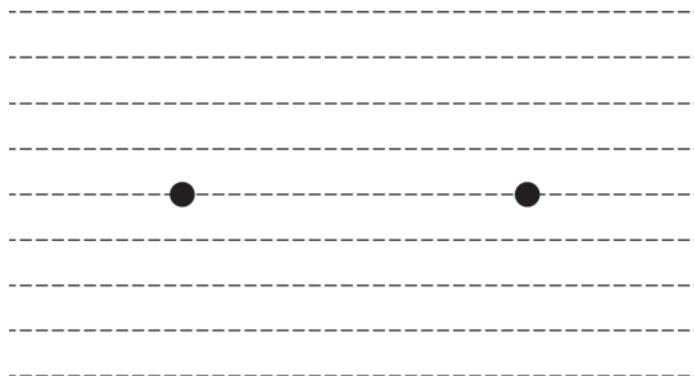
4. (7 points, suggested time 13 minutes)

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 $\frac{t_f}{2}$.

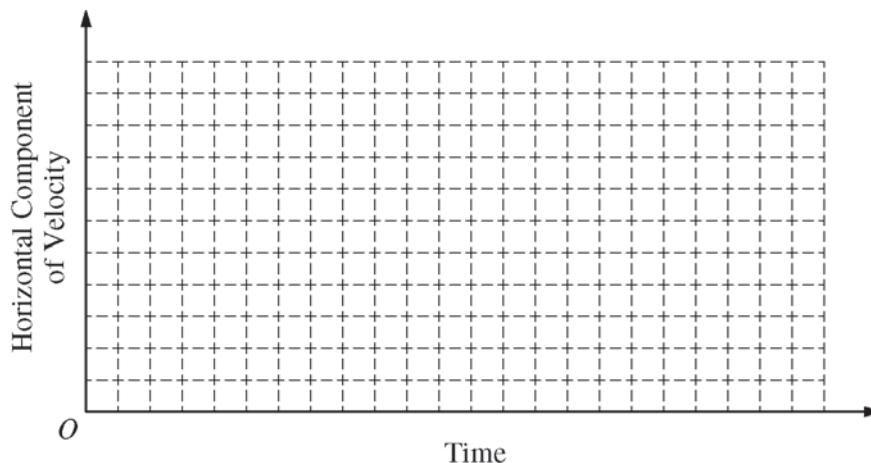
Sphere A

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

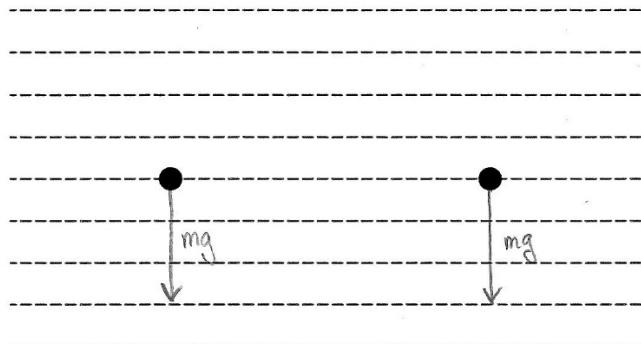
7 points total

(a) 1 point

Distribution of points

Sphere A

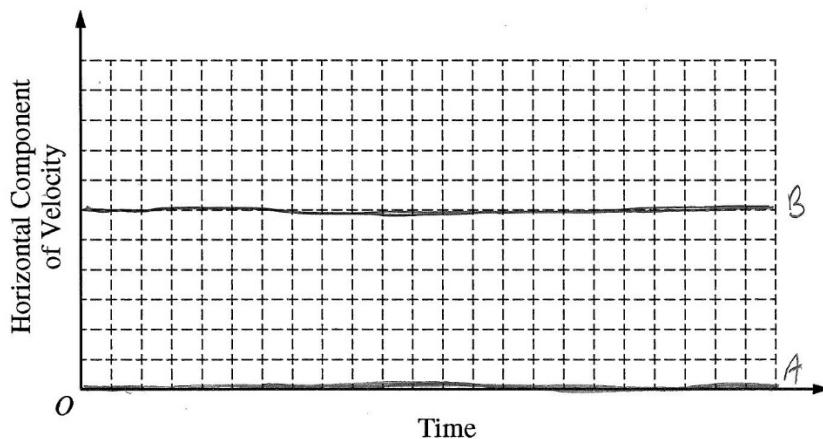
Sphere B



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

For indicating that both spheres have the same vertical acceleration

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

For no incorrect or irrelevant statements

1 point

1 point

1 point

1 point