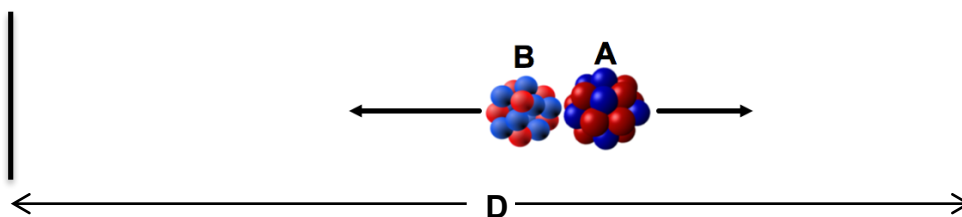


EXAM D Kinematics + Vectors FRQ 2017-2018

1. (12 points – suggested time 20 minutes)

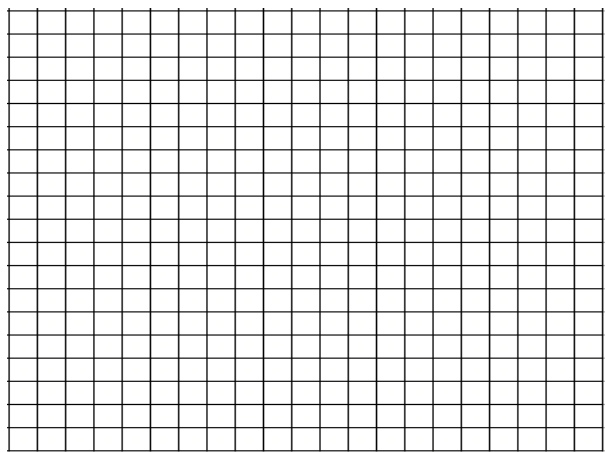
Two charged particles, A and B, are at rest next to each other in a particle accelerator (their size is so small that it can be ignored, and you can assume they start at the same location). An electric field is switched on at $t = 0$, and the particles accelerate in opposite directions with accelerations a_A and a_B , respectively. Particle A is more massive than particle B, such that $a_A < a_B$. At some point in time, the particles will be separated by a distance D .



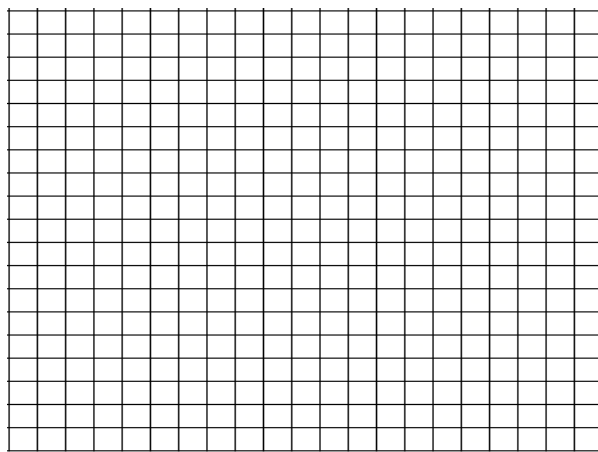
A. (2) Solve for the time t_D , when the particles are separated by the distance D , in terms of given variables.

B. (4) Sketch the position vs. time and velocity vs. time graphs for each of the particles from $t = 0$ to $t = t_D$. Clearly label curves with “A” and “B” as necessary.

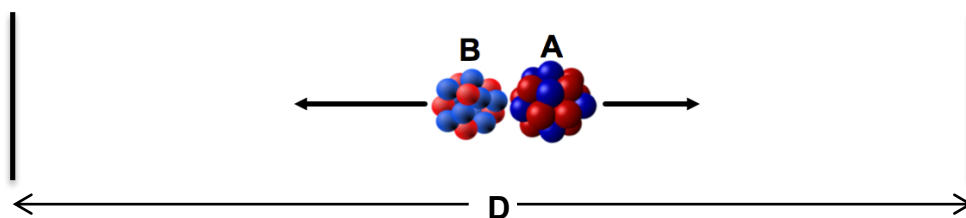
Position vs. time



Velocity vs. time



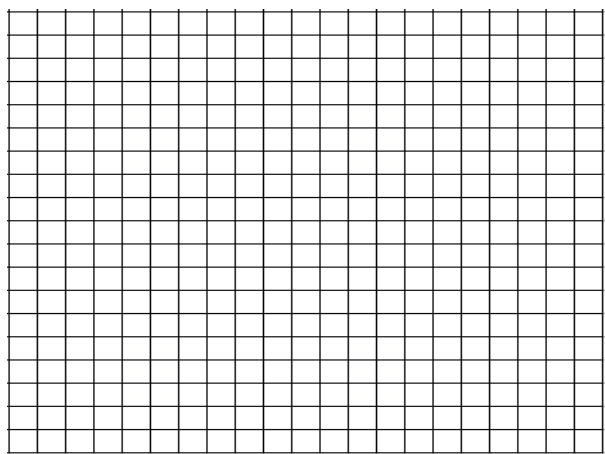
In a similar experiment using identical particles, the particles start in a location in the middle of the side barriers. The electric field is switched on, and the particles accelerate in opposite directions as before, with the same magnitudes of acceleration.



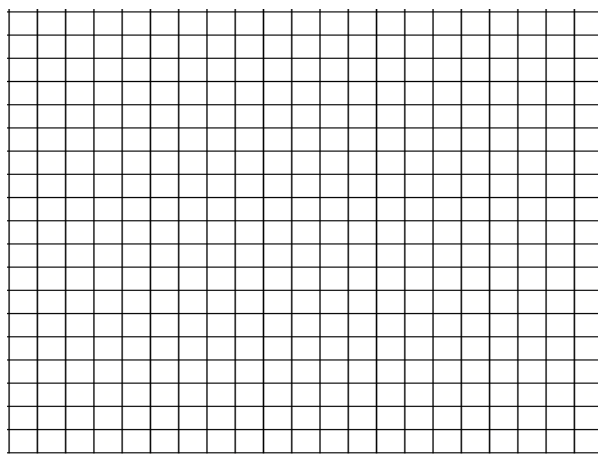
ii. (2) Describe a process you would use to determine the time *difference* between when the particles strike their respective barriers.

D. (4) Sketch the position vs. time and velocity vs. time graphs for each of the particles from $t = 0$ to when each hits its barrier. Clearly label curves with “A” and “B” as necessary.

Position vs. time



Velocity vs. time



2. (7 points – suggested time 10 – 15 minutes)

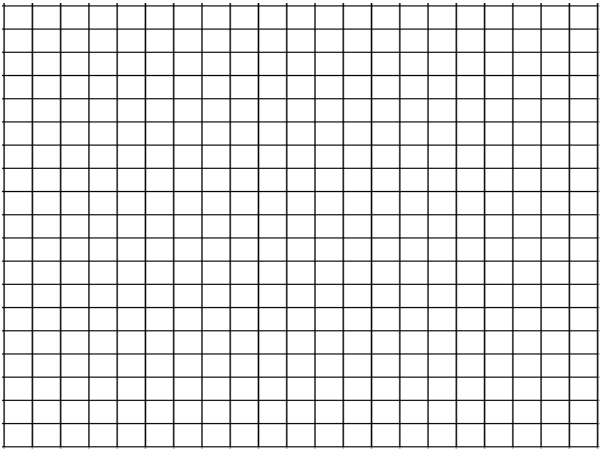
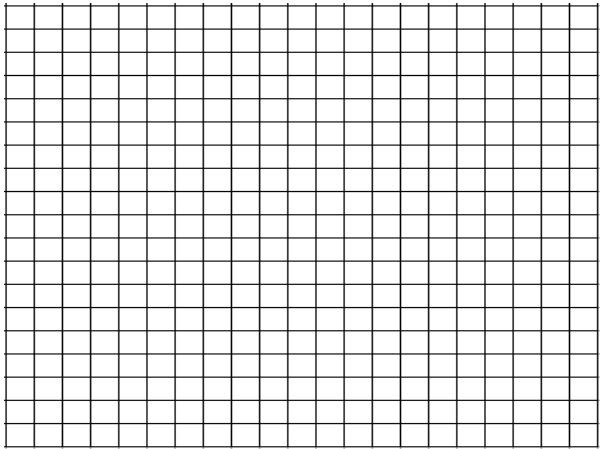
A rubber ball is dropped from the top of a tall building of height H . The ball bounces, reaching a maximum height of h *after* the 1st bounce.

	Down 1	Up	Down 2
x_0			
x			
v_0			
v			
a			
t			

A. Fill in the kinematics table from the drop to just before the 2nd bounce. The origin is at ground level.

B. Which quantities in the table are identical, with the exception of the acceleration? Which quantities in the table have the same magnitude with opposite directions?

C. Sketch the position vs. time and velocity vs. time graphs for the ball from the drop to just before the 2nd bounce. Assume the bounce itself takes a very short time. Label the axes appropriately and indicate maxima and minima.



3. (6 points – suggested time 10 minutes)

A. Describe a situation in which the final position of an object at the end of a particular time interval is equal to the displacement of the object during the interval.

B. Describe a situation in which the final position of an object at the end of a particular time interval is greater than the displacement of the object during the interval.

C. Describe a situation in which the final position of an object at the end of a particular time interval is less than the displacement of the object during the interval.