**Kinematics**

1 D Kinematics

Most, if not all problems involving constant acceleration, can be solved by evaluating a velocity vs time graph. More than using the three equations, this is a hugely important skill. Identifying what the slope and the area of a graph represent is an extremely important test taking skill and should be the first thing that students do when they see a graph of any sort on the test--even before they read the problem. The slope of a velocity vs time graph is acceleration and the area of a velocity vs time graph is displacement.

When there is a constant acceleration In a problem, the v vs t graph is a straight line of some sort, making it very easy to use to solve a problem. Drawing the knowns on to the graph makes it very easy to solve for the unknown. If students need to use the kinematic equations, it is important to note that the first step will always be solving for the acceleration. The format of the new AP exam is such that they will have very few opportunities to use the kinematic equations and will be better served by using the v vs t graph.

Projectiles

In order for an object to be considered a projectile, it must be in free fall. All objects near the surface of the earth experience the same acceleration due to gravity (10 m/s), regardless of their mass. This could be explained by saying that the weight of the object (the force due to gravity) depends on the object's mass, and to find the acceleration, the net force is divided by the mass. A more elegant explanation is that all objects at the same (or roughly the same) distance from the earth are in the same gravitational field and experience the same force per unit mass (acceleration).

The only force acting on a projectile is the weight, nothing else, meaning that a projectile can only accelerate in the y-direction. One of the things that makes projectiles solvable is the independence of X and y motion: motion in the X direction for an object is independent of the option in the y direction. This means that the x component of the motion has constant velocity and does not affect the y component. The y component of the velocity behaves exactly like an object dropped or thrown straight up into the air. It stops at the highest point as it turns around without the acceleration of the object changing.

**Multiple Choice**

1. A toy dart is fired straight up into the air. Ignoring air resistance, when the dart reaches its maximum height, its velocity is
2. maximum
3. minimum
4. equal to its displacement multiplied by the time
5. equal to 0 m/s
6. equal to 9.8 m/s2
7. A toy dart is fired straight up into the air, and returns to its original position. In the absence of air friction, the total displacement of the toy dart is
8. zero
9. equal to twice the upward distance traveled
10. equal to the average speed of the dart divided by the time it was in the air
11. equal to the average speed of the dart divided by the acceleration due to gravity
12. equal to the final and initial speeds of the dart divided by the acceleration due to gravity
13. A Triumph sports car accelerates uniformly from rest to a speed of 30 m/s in 6 s. Calculate the distance the car travels in this time interval,
14. 5 m
15. 15 m
16. 90 m
17. 180 m
18. 360 m
19. A ball is dropped from the top of a building. In the absence of air resistance, the ball will hit the ground in 4.5s. The height of the building is
20. 25 m
21. 44 m
22. 240 m
23. 101 m
24. 10 m
25. A projectile was fired at 35 degrees above the horizontal. At the highest point in its trajectory its speed was 200 m/s. If air resistance is ignored, the initial velocity had a horizontal component of
26. zero
27. 200 cos (35º) m/s
28. 200 sin (35º) m/s
29. 200/cos (35º) m/s
30. 200 m/s
31. Which of the following is NOT true of a projectile launched from the ground at an angle?
32. The horizontal velocity is constant
33. The vertical acceleration is upward during the first half of the flight and downward during the second half of the flight
34. The horizontal acceleration is zero
35. The vertical acceleration is -10 m/s2
36. The time of flight can be found by horizontal distance divided by horizontal velocity



7. A tennis ball is thrown upward at an angle from point *A*. It follows a parabolic trajectory and hits the ground at point *D*. At the instant shown, the ball is at point *B*. Point *C* represents the highest position of the ball above the ground. How do the *x* and *y* components of the velocity vector of the ball compare at the points *B* and *C*?

1. The velocity components are non-zero at *B* and zero at *C*.
2. The *x* components are the same; the *y* component at *C* is 0 m/s.
3. The *x* components are the same; the *y* component has a larger magnitude at *C* than at *B*.
4. The *x* component is larger at *C* than at *B*; the *y* component at *B* points up while at *C*, it points downward.
5. The *x* component is larger at *B* than at *C*; the *y* component at *B* points down while at *C*, it points upward.

Questions 8 – 10: The graph below shows the velocity of an object (v) as a function of time (t).



8. What is the displacement of the object during the first four seconds shown?

1. 0 m
2. 8 m
3. 12 m
4. 16 m

9. At which of the following times is the object at rest?

1. 1 s
2. 4 s
3. 6 s
4. 0 s

10. During which of the following time intervals is the object speeding up?

1. 0 s – 2 s
2. 2 s – 4 s
3. 4 s – 6 s
4. 6 s – 9 s

Directions: For each of the questions below, two of the suggested answers are correct. For each of these questions, you must select both correct choices to earn credit.

11. A track athlete runs one complete lap around the track, starting and stopping at the same point. Which of the following quantities are zero for the athlete during this time?

1. distance
2. displacement
3. average velocity
4. average speed

12. Which of the following graphs of position vs. time or velocity vs. time show an object that is speeding up?

