Motion Test Review (Projectiles, Freefall & Horizontal)  

1. A racecar comes to a stop with a constant acceleration of $-11.0\, \text{m/s}^2$. If the car was going $+55\, \text{m/s}$, how many meters will the car travel as it comes to a complete stop?

2. A ball is thrown vertically with a velocity of $+25.0\, \text{m/s}$.
   a. How high does it rise? $v_f^2 = v_i^2 + 2ax$  
      $0^2 = (25)^2 + 2(-9.8)x$  
      $x = 31.4\, \text{m}$
   b. How much time does it take to reach its highest point? $v_f = v_i + at$  
      $0 = 25 + (-9.8)t$  
      $t = 2.55\, \text{s}$
   c. How long does it take to reach original height AFTER it reaches its highest point?  
      $t_{up} = t_{down}$ because it will travel same distance up and down and is only affected by gravity  
   d. What is the velocity of the ball when it returns to the level from which it was thrown?  
      Same as initial velocity, except negative (moving down) because the ball moves the same distance while affected by gravity

3. The ball in the diagram below starts at origin from rest and rolls through the frictionless course as shown below, coming to rest at the far right on the diagram.
   a. Draw a motion map on the diagram for movement of the ball from beginning to end of motion.
   b. An acceleration vector diagram for any part of the motion the object accelerates.
   c. The three motion graphs.

4. The graph below represents the motion of an object.

   a. At what point(s) on the graph above is the velocity of the object zero? Explain.  
      $B, F$  
      slope is zero; object at rest
   b. Over what intervals on the graph above is the object’s velocity increasing? Explain.  
      From $E$ to $G$  
      The graph has a positive slope (velocity) at $E$ and it changes to zero slope at $F$ and positive at $G$
   c. Over what intervals on the graph above is the object’s velocity decreasing? Explain.  
      From $A$ to $C$  
      Positive to zero to negative slope
d. At what point(s) on the graph above is the object changing direction? Explain.

5. For each of the graphs shown below, draw the corresponding motion graphs. Then, write a brief statement that accurately summarizes the motion of the object.

True/False: Determine if each is True or False and give a brief explanation of why?

6. The horizontal velocity of a projectile is constant. (No horizontal acceleration)

7. The vertical acceleration of a projectile is 0 m/s². (Vertical acceleration due to gravity, g = 9.8 m/s²)

8. When two bullets are simultaneously fired horizontally and dropped from the same height, the fired bullet remains in the air for more time. (Both affected by gravity vertically in the same way)

9. The magnitude of vertical displacement of a projectile launched horizontally is equivalent to its height. (Yes, horizontal displacement would be zero)

10. The curved path of a projectile is parabolic. (Vertical acceleration but no horizontal acceleration)

11. Gravity affects both the vertical and horizontal motion of a projectile. (Only vertical)

12. Projectiles move vertically and horizontally simultaneously. (Shown in parabolic path)

13. When air resistance is ignored, the mass of a projectile does not impact its motion. (Similar to objects in the fall)

14. Draw and complete a kinematic chart (2 columns) for a projectile launched horizontally: \[ \begin{array}{c|c}
\text{Horizontal} & \text{Vertical} \\
\hline
v_0 & v_0 \\
0 & a_g = g \\
\hline
\end{array} \]
15. Draw and complete a kinematic chart (3 columns) for a projectile launched at an angle.

16. A student rides in a wagon that is moving forward at a constant velocity. The student throws a tennis ball straight up into the air. Where does the tennis ball land?
   a. In front of the wagon
   b. In the wagon
   c. Behind the wagon
   d. Cannot be determined

   Explain your reasoning:
   Both the wagon and tennis ball are moving with the same initial horizontal velocity and they continue to move forward at a constant rate so they will have moved toward the same distance.

17. Two golf balls of identical mass are rolled off the edge of a 1.5 m tall table. One of the golf balls lands 0.5 m from the edge of the table while the other lands 1.0 m from the edge of the table. How could this have occurred?

   The one that lands 1.0 m from the table was moving at a higher horizontal speed (twice as fast).

18. A bowling ball and a tennis ball are both rolled off the edge of a table and land on the floor. If both objects roll off the edge of the table at 4.5 m/s. Compare the values for each of the following variables and explain your reasoning:

   a. Horizontal displacement:
   b. Vertical displacement:
   c. Vertical acceleration:
   d. Horizontal acceleration:
   e. Time of fall:
   f. Final vertical velocity:
   g. Final horizontal velocity:

   The bowling ball and tennis ball would both have identical values for all aspects because the mass is irrelevant. They both rolled off the same table at the same speed and were only affected by gravity.

19. Observe the diagram below and answer:

   Two students throw two rocks horizontally from a cliff with different velocities. Both rocks hit the water below at the same time but Rock B hits farther from the base of the cliff. For this exercise, you should ignore air resistance. Use coordinates where up is the positive vertical direction, away from the cliff is the positive horizontal direction, and the origin is at the top of the cliff at the point of release.

   Sketch below velocity vs. time graphs for each rock.