Test 1: Vectors and Kinematics

1. Suppose there are three swimmers that are attempting to cross a river of width, w. The river has a current of magnitude $v_{current}$, the three swimmers are having a race. Swimmer 1 attempts to cross the river by swimming directly across, swimmer 2 crosses the river by swimming with the current, and swimmer 3 crosses the river and swims against the current. All swimmers tie, how is that possible?

2. A race car driver is able to go around a circular race track of radius 10 km in 10 s.
    a. What is the average speed of the race car driver?
    b. What is the average velocity of the race car driver?

3. Angelo wants to get to school, he walks 3 units up, 3 units right, and 4 units down to get to school. He does this in 10 seconds.
    a. What is the total distance Angelo walked?
    b. What is the total displacement of Angelo?
    c. What is Angelo's average speed?
    d. What is Angelo's average velocity?

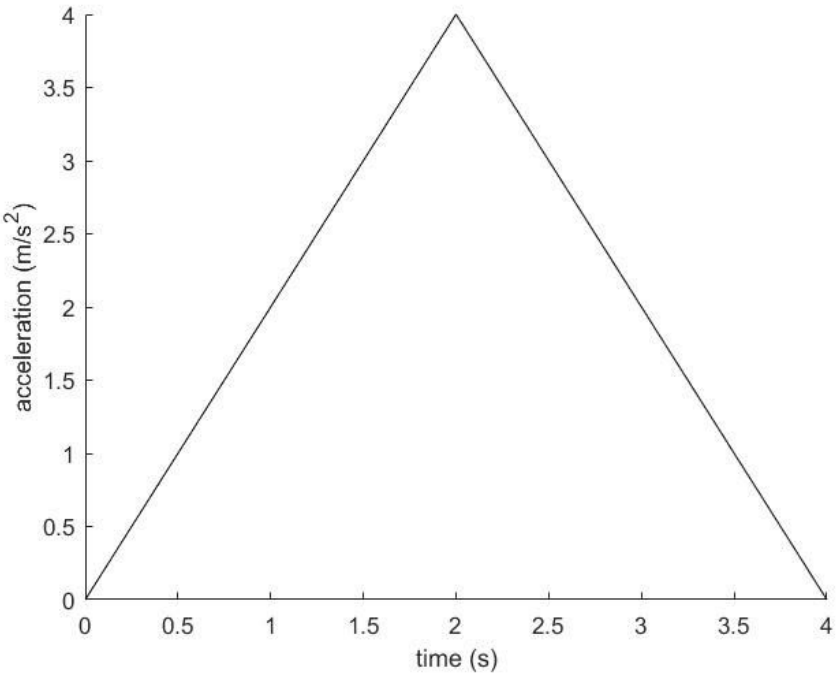
4. When can two vectors ever add up to be zero?

5. If there are two vectors, A and B such that A is 5 units to the right and B is 5 units downward, what is their vector addition? What angle is there between A and (A+B)? What angle is there between B and (A+B)?

6. If there is a resultant velocity vector of magnitude v at an angle θ with respect to the vertical, what is the horizontal component and vertical component of the velocity in terms of v and θ?

7. Fill In The Blank: In order to calculate a resultant vector from its components, one must use _____ _____, in order to isolate a component of a resultant vector, one must make use of _____ and _____. In order to find the angle between a resultant vector and its components, one must make use of _____ _____ functions.

Please refer to the graph for questions 8 - 11



8. When does the object depicted in the graph reach its maximum velocity?

9. The object depicted in the graph is undergoing which type of motion?

a) Uniformly accelerated
b) Non-uniformly accelerated
c) Zero acceleration
d) None of the above

10. The velocity graph from t = 0 s to t = 2 seconds would resemble what graph?

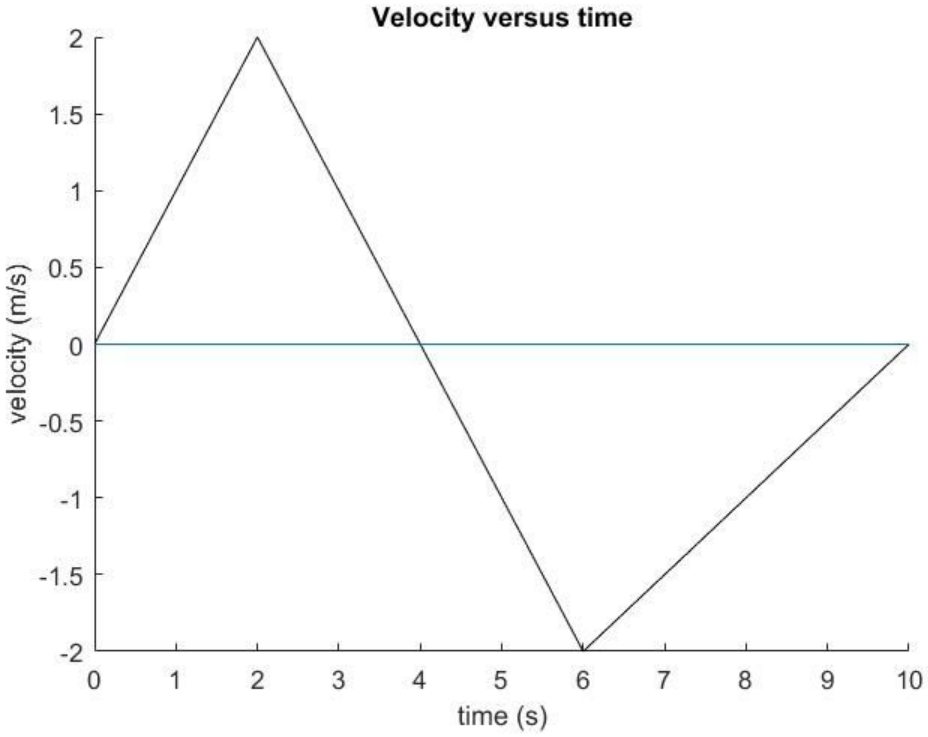
a) Positively sloped linear
b) Negatively sloped linear
c) Positive parabolic
d) Negative parabolic
e) Cubic
f) None of the above, the acceleration graph gives no information about the shape of the velocity graph.

11. The velocity graph from t = 2 to t = 4 seconds would resemble what type of graph?

a) Positively sloped linear
b) Negatively sloped linear
c) Positive parabolic

d) Negative parabolic
e) Cubic
f) None of the above, the acceleration graph gives no information about the shape of the velocity graph.

Please refer to graph below for questions 12 - 18



12. The object depicted in this graph is undergoing what kind of motion from t = 0 to t = 2?
a) Zero acceleration
b) Non-uniformly accelerated motion
c) Uniformly accelerated motion
d) None of the above

13. What is the farthest the object goes in the positive x direction?
a) 6m
b) 8m
c) 4m
d) 10m
e) None of the above

14. At what time does the object return to its original position?

a) 4s
b) 2s
c) 6s
d) 10s
e) Between 6s and 10s
f) Between 4s and 6s
g) Between 0s and 2s
h) Between 2s and 4s
i) None of the above

15. What is the object's acceleration from t = 0s to t = 2s?

a) 1 $\frac{m}{s^2}$
b) 2 $\frac{m}{s^2}$
c) 4 $\frac{m}{s^2}$
d) None of the above

16. What is the object's acceleration from t = 2 s to t = 4s?

a) 1 $\frac{m}{s^2}$
b) -1 $\frac{m}{s^2}$
c) -2 $\frac{m}{s^2}$
d) 2 $\frac{m}{s^2}$
e) None of the above

17. What is the object's acceleration from t = 2s to t = 6s?

a) 1 $\frac{m}{s^2}$
b) -1 $\frac{m}{s^2}$
c) -2 $\frac{m}{s^2}$
d) 2 $\frac{m}{s^2}$
e) None of the above

18. What is the object's acceleration from t = 6s to t = 10s?

a) 1 $\frac{m}{s^2}$
b) -1 $\frac{m}{s^2}$
c) -2 $\frac{m}{s^2}$
d) 2 $\frac{m}{s^2}$
e) None of the above

19. Suppose a ball is dropped from a cliff of height 100 m.
    a. How long does it take the ball to reach the ground?
    b. How fast does the ball hit the ground?
20. Suppose a ball is launched from the side of a cliff that is 345m above the ground at a speed of 25 m/s.
    a. How far does the ball travel from the base of the cliff?
    b. How long does it take the ball to hit the ground?
    c. How fast does the ball hit the ground?

21. Suppose a jet plane travels at a constant 1000 km/hr between time t = 0 s and t = 6 s, after t = 6s, an enemy jet begins approaching and you must change direction, your acceleration after t = 6s is 10 m/s in the negative direction.

a. After what time would you return to your initial position?
b. After what time would you have a velocity of -500 km/hr?
c. At time t = 9 s, what would your position be?
d. At time t = k s, what would your position be?
e. Find a formula that would allow you to find the velocity of the jet plane starting from t = 0 s. (hint: this is possibly a piecewise formula)
f. Find a formula that would tell you the acceleration of the jet plane starting from t = 0 s.
g. Find a formula that would allow you to find the position of the jet plane starting from t = 0 s.

22. Suppose a cannon fires and sends its projectile at an astounding speed of 200 m/s at 45 degrees above the horizontal.
    a. What is the vertical component of the object's velocity
    b. What is the horizontal component of the object's velocity
    c. What is the maximum height achieved by the projectile?
    d. How long does it take the projectile to land?
    e. How long does it take the projectile to reach its maximum height?
    f. How far does the projectile travel?

23. A jet's engine is capable of accelerating the aircraft from rest to 250 m/s in only 2 seconds flat. What is the acceleration of the aircraft assuming it is constant?

24. An object begins from rest and accelerates to 5 m/s with an acceleration of 1 $\frac{m}{s^2}$, how far did it travel?

25. Derive the formula $v_f^2 = v_i^2 + 2a\Delta x$
26. Derive the formula $\Delta x = v_i t + \frac{1}{2}at^2$
27. Derive the formula $v_f = v_i + at$
28. What happens to the degree of the polynomial that can represent the displacement graph as you go from displacement to velocity to acceleration? (hint: degree 2 = parabolic, degree 1 = linear, degree 0 = horizontal line)
29. What is the only quantity that can be applied to the x and y direction when doing a two dimensional kinematics problem?
30. Why is the acceleration in the horizontal direction always equal to 0 $\frac{m}{s^2}$ when doing kinematics problems?